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Integrators' Air Network

**A review of the Domestic Express
European Market**

School of Engineering

MSc Air Transport Management

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Integrators' Air Network

A review of the Domestic Express European Market

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The express industry witnessed dramatic growth during the 1990's with an economic environment changing toward globalisation. Integrators' international expansion has been supported by extensive transportation networks applying the model developed by FedEx: the hub and spoke model.

This report investigates integrators' air network configurations within a specific geographical area: the intra-European market. The research has been focused on the big four integrators, DHL, FedEx, TNT and UPS and provides an analysis on their strategy. Before presenting integrators, a review of the different network models presents the major role played by the Hub and Spoke network in the express freight industry. This model is one of the strategic foundations of the integrators' success.

Afterwards, the paper deals with three objectives. It first identifies the hub and spoke network configurations selected by integrators in Europe. Then, work uncovers the drivers behind network configuration. Finally, the key factors influencing the European Hub location are discussed through the case of the DHL move to Leipzig. This paper provides a location analysis and compares Brussels to Leipzig in term of distance to the core market.

This paper brings several conclusions. First of all, there is a strategic area to locate a central hub in Europe, between Amsterdam Liege & Paris. Moreover several factors influence central hub selection as followed: market proximity, Airport capacity¹, environmental restrictions², operational cost and capacity of driving traffic are the key factors. Secondly, two hub and spoke configurations are used by integrators in Europe, the single hub and spoke network with pickup stopovers and feeders and the multi-hub and spoke configuration. Finally, network configuration relies particularly on the size of business and the transport strategy elected.

¹ This term includes slots restrictions, runway capacity, and possibility of building logistic facilities.

² Includes night curfews and environmental concerns of the local community

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AHK : Air Hong Kong
BRU: Brussels
CDG: Paris Charles De Gaulle
CEP: Courier, Express, Parcel
CGN: Cologne Bonn
DPWN : Deutsch Post World Net
EEMEA: Eastern Europe, Middle East and Africa
FAA: Federal Aviation Administration
HKG: Hong Kong
ILM: Wilmington
LGG: Liege Airport
LH: Lufthansa
LYS: Lyon St Exupery
MEM: Memphis
RTK: Revenue Tonnes Kilometres
SDF: Louisville
SFS: Subic Bay
TSA: Taipei
UPU: Universal Postal Union
VIT : Vitoria

1 Introduction

1.1 Introduction

Born in the late 1970's just before the deregulation of the domestic US market, the express industry met a rapid success and a dramatic growth during the 1990's with an economic environment changing toward the globalisation and the development of logistic practices. This terrific growth has driven the success of integrated carriers.

"International express has grown at more than twice the rate of total worldwide air cargo traffic, averaging 12.9% ³annually over the past decade" (Boeing, 2006).

Integrators international expansion has been supported by extensive transportation networks applying the model developed by FedEx: the hub and spoke model. However, several factors have influenced the evolution of integrators strategy, such as the development of freight time-definite market, economic boom in Asia or India, merger and increase in competition level, fuel price instability and so on. These factors have influenced integrators in their transportation and network strategy.

Consequently, the purpose of this thesis is to state the current configurations of the Hub and Spoke model and determine the key factors behind it.

³ In tonnes kilometres

1.2 Rationale behind this study

Integrators' network configuration have been specifically analysed in the past using data modelling tools to solve issues related to hub location, or network performance. However, not many papers provide an analysis based on the four largest integrators' strategies regarding at hub location and network configurations. Furthermore, following discussion with professionals and academic specialists, the possible outcomes of this research could be valuable to better understand the cargo sector of the air transport industry.

1.3 Aims and Objectives

This paper provides an analysis of the main integrators' networks in a specific geographical area. The aim of this thesis is to compare the integrators' air network within the European CEP ⁴market and to determine the strategy and the factors explaining the current structure. In order to achieve these aims three objectives have been defined to pursue this research. These objectives are to:

- Determine the key factors influencing Integrators in European Hub selection through the case of DHL central hub moves.
- Identify hub and spoke network configurations selected by integrators
- Identify strategies behind such configurations

1.4 Chapter Structure

The thesis structure follows a classical format. Chapter 2, 3 and 4 provide the necessary background information to analyse the topic and the particular issues examined. Chapter 2 summarises the historical and contemporary literature relating to network analysis and presents the basic concepts. Chapter 3 gives an overview of the intra-European express market and defines the key elements, the market, the demand and the operators. Chapter 4 brings the reader further in the topic with a detailed description of the integrated carriers

⁴ Courier, Express, Parcel

considered within this study and their particular strategies. Following this background section, chapter 5 states the research approach and methodology. Finally chapters 6 and 7 respectively provide the results and the conclusion of this analysis. Chapter 6 provides a clear description and analysis of the air networks operated by integrators in the intra-European market before concluding and providing recommendation for further research on the topic.

1.5 Limitations

The airline industry is remarkable in its dynamic nature and the air express sector is no exception in encompassing a very wide range of complicated issues. The analytical part of this thesis has been limited due to reasons such as inaccessibility to commercially confidential data. Consequently assumptions have been drawn from qualitative data obtained.

Furthermore, the scope of the paper is geographically limited to the intra-European networks in order to provide a more specific analysis. The regional scale is the lowest possible when looking at integrators' networks due to an intensive use of hub and spoke network and long distance flights. The intra-European case has been selected for different reasons. First of all, an information collection concern was very sensitive. The data collection process was based on a European network of contacts. Secondly, the European area is the home market for two of the four main integrators and benefits from intensive competition. Thirdly, several specificities of the European market may influence network strategy such as regulation and economic concentration.

2 Air Networks

2.1 Chapter Overview

Airline networks have been broadly reviewed in the past. Several books and papers are dedicated to issues related to this topic. For the purpose of this study, the relevant period considered research done from the mid 80's up to contemporary ones. The recent papers, such as "International Air Network structures and air traffic density of world cities" by Matsumoto (2007), or "Airline Network Development in Europe and its implication for Airport planning" by Burghout (2006) show a continuous interest for issues around the topic. The majority of researches done in this topic area are passenger-related, due to a probable greater interest for this part of aviation. However within this paper, freight based studies are deeply considered and differ from passenger ones.

The Hub and spoke model occupies a significant place in air network studies and so benefits from deep theoretical analysis. The spatial approach has been the most popular way to analyse hub and spoke networks (Burghout G, 2006). However, another approach, temporal, has been more recently examined, particularly in the passenger business. For the purpose of this study, it is relevant to analyse this temporal approach since in the real world, express courier and package companies have used several methods applied in the passenger industry.

The objective of this chapter is to define the key concepts of air network theory, to present the different theoretical approaches and the different network configurations. This chapter is divided into three parts. Firstly, a series of relevant key concepts and definitions are presented, before a brief presentation of the key network configurations. Finally, a deeper description of Hub and Spoke models, with strategic issues, is introduced to the reader.

2.2 Definition of Network in air transport industry

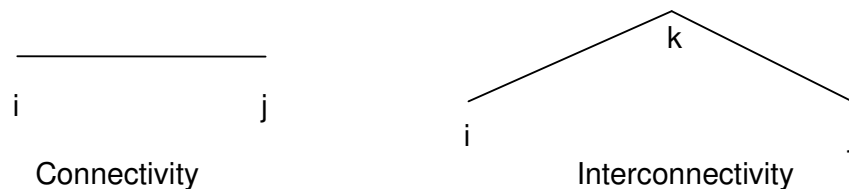
The term “network” is a broad term used in many situations and represents different concepts. For the purpose of this study a few aviation-oriented definitions have been taken into consideration.

A network can be defined as “a collection of nodes connected by facilities through which entities pass” (Button and Stough, 2000). It can be either physical or non physical. Airline networks are a mix between physical (airports) and non physical (air routes) components. Burghout (2006) insists on the connectivity of a network.

“A network is defined as a set of interconnected nodes”.

However, he notes that the “connectedness” is not simply spatial but also temporal (Burghout, 2006). Button (2002) preferred using the terms connectivity and interconnectivity. Connectivity is seen as the connection between two points and interconnectivity involves at least three nodes, as presented in the figure below.

Figure 1: Difference between connectivity and interconnectivity⁵



In most case, choices in network configuration are likely to be a function of factors such as external institutional factors⁶, availability of airport capacity or entry regulation, but also of economic considerations (Button, 2002). Indeed, a

⁵ Button, 2002

⁶ i.e. controls on flights routing

network has to perform more than the simple objective of providing single link services between two points. The economic reliability of a network is in many cases the only reason for its sustainability. This economic aspect can be assessed on the cost side but it may also reflect the possibility of earning higher revenues on the demand side (Button and Stough, 2000). The development of a new network model has been driven by economic interests for several reasons such as economies of scale or higher revenues associated with a particular network configuration. Another driver of the network configuration is the customer.

Finally, in the aviation industry, route networks have not always been of prime concern in airline strategy, due to several factors. At the origin of aviation, airline network development relied to a large extent on technological development in aircraft performance. Indeed, early services consisted of multi-stop, point-to-point flights using capacity aircraft over short distance due to limited performance (Berdy P, 2002). Moreover, up to 1978 in the domestic US market and 1997 in the intra-European market, airline networks were considerably regulated by authorities. However, this is still the case for a significant number of international connections.

The different elements in a network

Burghout (2006) distinguishes three basic types of nodes forming part of a network in aviation industry: the station, the traffic node and the hub. The function of these nodes varies based on spatial and temporal dimensions as presented in the table below (Burghout, 2006).

Table 1: Taxonomy of nodes in an airline network ⁷

	Spatial Configuration of the node		
	Decentral		Central
Temporal configuration of the node	No wave system Structure in airline flight schedule	Airline Station Feeder destination/spoke/rim airport/non-hub	Traffic node Continuous hub
	Wave system structure in airline flight schedules	Intermediate node	Hub, Traffic hub, Hinterland hub, Directional/hourglass hubs, Allround hub, Eurohub, Specialised hub, Global hub, hyper-hub, Mega_hub, Super-hub

The airline station

The Airline station is the most basic function of a node in the air (see table 1 above). It can be visualised as a simple origin or destination point, from which “only air flows can originate or into which only flows destined for it can enter” (Burghout, 2006), without any temporal or spatial junctions. It is used as feeder origin-destination or as a spoke in a hub and spoke network configuration. However, despite a small number of direct connections in a single airline network, the spoke benefits from a “large onward connectivity through the hub” (Burghout, 2006).

The traffic node

The traffic node is considered as a central node, a key role in airline networks (see table above). It benefits from a large origin–destination market which involves frequent operations and so, can be used to transfer passenger flows and become a transfer node⁸. Moreover, it tends to benefit from a central position spatially, and consequently can generate indirect connections. One of the derivatives of the traffic is the continuous hub. An example of this type of node is London Heathrow (Burghout, 2006).

⁷ Burghout, 2006

⁸ 20-30% of the total number passengers according to Burghout (2006)

The Hub

Ivy (1993) defines a hub as “a central collection point or node in a transportation system or network”. As shown in table 1 above, a hub performs, both spatially and temporally, a central position in the network. Berdy (2002) offers another view of the role of the hub. He sees hubs as a way to minimize the risk that an aircraft/aeroplane will depart with too many empty seats. However, he presents a limitation of hub utilisation. A hub needs enough “critical mass” to add new flights for connecting or flow traffic as well as flights to serve local markets.

Usage of the term, however, has become particularly applied for the air transportation industry in the USA, since the deregulation and the development of the Hub and Spoke system (Ivy R.L., 1993).

2.3 Model Presentation

Burghout (2006) tried to elaborate a classification of the different network structures depending on the spatial and temporal concentration as presented in table 2 below.

Table 2: The airline network configuration matrix ⁹

Level of spatial concentration	Level of temporal concentration at the hub	
	Co-ordinated	Random
Concentrated	Hub and Spoke	Random radial
Deconcentrated	Co-ordinated / deconcentrated	Point-to-Point

Identifying clearly the network configuration used by companies has revealed to be a difficult task because networks are very dynamic with links being continually added and removed (Button, 2002). Despite recognising airline networks as “a mixture between different forms”, Burghout (2006) made a geometrical classification (see figure 2 below). Indeed, according to him, within most of the hub and spoke networks, some spoke cities have direct services between them, and even in mainly point-to-point type networks some traffic is consolidated over transfer points.

⁹ Burghout, 2006

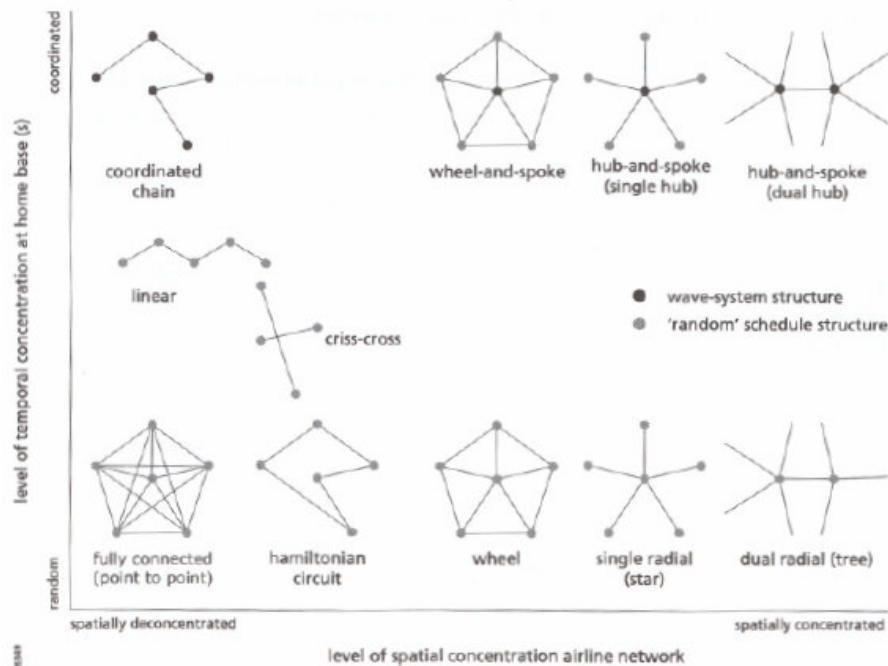
Figure 2: Time-space continuum of airline network configurations¹⁰

Figure 2 above aggregates most of the network configurations established in air transportation. The graph classifies the different models depending on the temporal and spatial concentration level. The two main models are the fully connected point-to-point at the bottom left hand corner of the graph and the single hub and spoke models at the top right hand corner. These two types of network are opposites. As presented in the graph, there are several hub and spoke configurations such as single hub, dual hub and wheel-and-spoke but the first two are the most used for integrators' networks. A more detailed description is presented to the reader in the following section.

¹⁰ Burghout 2002

2.4 The Hub-and-spoke model

A concept used in different businesses such as telecommunication, Information Technology, or transportation, the hub-and-spoke model was introduced in aviation in 1973 by the founder of FedEx, Fred Smith. The concept, pioneered by FedEx using Memphis (Chan, 1994), has met with terrific success since the Airline Deregulation Act in 1978, forcing the American air industry into a competitive market situation (Ivy, 1993). One of the consequences was the change in airline network geography driven by higher priority for flow efficiency and cost reduction. “Airlines were trying to concentrate flights on one or more key regional nodes in their networks to raise load factor and aircraft utilisation.” (Ivy, 1993)

With the expanding use of this model, during the 1980's, hub network issues started to become the subject of scientific studies. As the hub and spoke network strategy has been applied in the passenger and freight transport business, scientists have been concerned by both applications. Despite a significant evolution of the model, most of the research has been focused on the “pure” hub and spoke network. Kuby and Gray (1993) analysed the case of the pioneer of the Hub and spoke system and realised that economic reality is not so close to the pure model¹¹.

2.4.1 Definition

Burghout (2006) published fourteen relevant definitions of the Hub and Spoke network. Some are passenger related, for Berry & al or Dennis who consider a hub and spoke network, for the first one, as a fact when passengers change planes at a Hub airport to another destination, and the second Dennis who uses the concept of origin, destination and connecting passengers in the purpose of flying internationally.

¹¹ Kuby and Gray analysis will be presented later in this paper

Separately, Button (2002) and Kanafani & Ghobrial (1985) provide airport related views. Indeed, the first author states that the model is used by an airline of one or more large airports, with flights operated in banks to consolidate outbound flights. The second one characterises the concept as a collection – distribution centre for passengers.

Two authors, O'Kelly (1986) and Shaw (1992) have an interesting approach to define the model. O'Kelly defines hubs as special nodes with a particular location to facilitate connection. Shaw uses both the geographical and collection/distribution concepts with functions to connect a set of nodes.

In order to summarize, the hub and spoke model has been described as a flow concentration into a central node, the hub, to which are connected numerous spokes. Spokes have been explained by Berdy (2002), as cities served on inbound or outbound flights to/from a hub. Moreover, Berdy (2002) considers that the basic role of a hub is to cross connect flights. It means connecting at least two aircraft arrivals and departures.

Difference between passenger and freight oriented hub and spoke model

Despite a common use of the model, applications and theory show some distinction between the freight and passenger view Hub and Spoke networks.

First of all, operating conditions are substantially different regarding operability constraints. According to Kuby and Gray (2003), on the passenger side, the customer is unwilling to make large detours on their journey which tends to influence passenger-airlines using multi hub systems. However, in the cargo or courier market, detours are not a problem as long as the package arrives on time; the customer does not care how it is routed.

Consequently, air cargo operators can find it easier to focus on the single mega-hubs and pass through it large volumes of shipments during the night time. However, in express operations, despite the fact that the customer does not care about the routing, the time window does not allow large detours. Another difference between cargo and passenger network organisation is the impact of airport congestion. Kuby and Gray (1993) notices that it is impossible

for an airline to monopolize facilities for a long enough period of the day (up to 2 hours) to fully use the wave system of the hub. The obvious way to escape congestion is to operate from an airport serving a smaller city, which has the disadvantage of bring of low origin-destination traffic necessary for a base for passenger airlines. The difference is that low traffic is less penalizing for cargo, as flights takes place in the middle of the night. This is a main reason for the fact that express integrators have hubs in smaller centre, such as Wilmington ¹² or Subic Bay ¹³ where there are few other flights competing for night-time runway access (Kuby & Gray, 1993).

Advantages

Several advantages explain the expansion of this model over the past thirty years. The first reason is the possibility of increasing the market coverage with the same fleet. Two models have been developed to prove this argument. For Berdy (2002), in a Hub and Spoke configuration, the number of markets served ¹⁴by a hub grows exponentially as aircraft are added in the fleet. Taking the example of a hub with 50 aircraft, Berdy assumes that the airline can theoretically serve 2,600 destinations as presented in the table below. The formula used is the following, where “N” is the number of aircraft used:

$$N(2 + N)$$

¹² DHL hub in USA

¹³ Asia Pacific Hub of FedEx

¹⁴ Means destination served

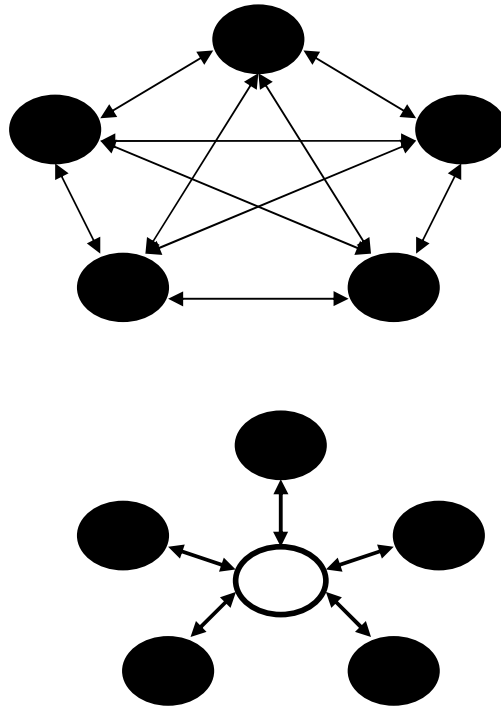
Table 3: Size of the fleet and market served relation¹⁵

Nb Aircraft	Market served		
	Local	Connecting	Total
1	2	1	3
2	4	4	8
3	6	9	15
4	8	16	24
5	10	25	35
6	12	36	48
7	14	49	63
8	16	64	80
9	18	81	99
10	20	100	120
20	40	400	440
30	60	900	960
40	80	1600	1680
50	100	2500	2600

Chan (1994) has used another calculation. According to him, the number of city pairs that an airline can serve for a given number of outputs increases significantly using a hub and spoke network compared to point to point. Indeed, if “ n ” points are to be served non-stop, $n(n-1)/2$ routes are necessary to satisfy all possible city-pairs. However, using a central node as a hub, the $n(n-1)/2$ city pairs can be reduced by “ n ”spokes. Taking the example of a network serving 5 cities as presented in the figure below, it is possible to understand the difference between both configurations. In the first example, in a pure point-to-point network the airline needs to operate 10 routes¹⁶ instead of 5 routes using a hub and spoke configuration.

¹⁵ Berdy 2002

¹⁶ $\frac{(5*4)}{2} = 10$

Figure 3: Difference between Point-to-Point and Hub and Spoke model

Moreover, a hub and spoke configuration allows unit cost reduction and load factor increase using economies of scale. Consequently, the processes are more efficient and resources, particularly the specialist ones, benefit from better allocation (Chan, 1994).

Disadvantages

Hub and spoke configurations provide a series of benefits compatible with express operations; however, this system is not perfect and brings a series of disadvantages. First of all, according to Chan (1994) the journey time increases more or less significantly, depending on the extra distance flown, due to back track. Secondly, as journey times rise, several costs in connection to it augment in consequence, such as crew cost, fuel cost, and other operating costs. Finally, a hub is often vulnerable to congestion and so can become unreliable (Chan, 1994). Berdy (2002) determines some issues in relation to passenger business but that could be applicable to the express industry. A hub can reach saturation in some cases. Taking the example of the fifty aircraft case described above,

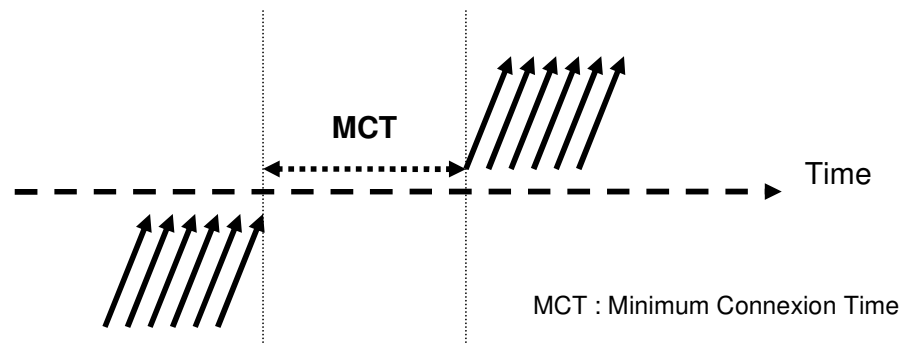
airlines need to flow traffic directionally to all of the 2,600 destinations in order to obtain maximum profit. The problem is that there are only a few geographical locations where hubs can serve numerous cities in the same direction without increasing significantly the length of the passenger journey and without having to add massive capacity at hub airports (Berdy, 2002).

2.4.2 Design of a hub and spoke network

Chan (1994) identifies three characteristics for an effective hub. Firstly, the hub location must be central to the market served in order to reduce back-track. One of the advantages is the uniformity of flying time for each hub and spoke pair. Secondly, the airport selected must provide sufficient facilities such as runway capacity, space for sorting facilities and cargo handling facilities during the required time slots. In the case of the express business, night slots must be available.

Finally, the schedules have to be coordinated to waves of aircraft arrivals and departure in order to maximize the number of connections while minimizing the time spent on the ground as presented in figure 4 below.

Figure 4: Wave system in hub and spoke configuration ¹⁷



Before going further to the scheduling process, a series of technical terms need to be defined. The term “wave” (or “bank”) is defined as a combination of arrival

¹⁷ Chan 1994

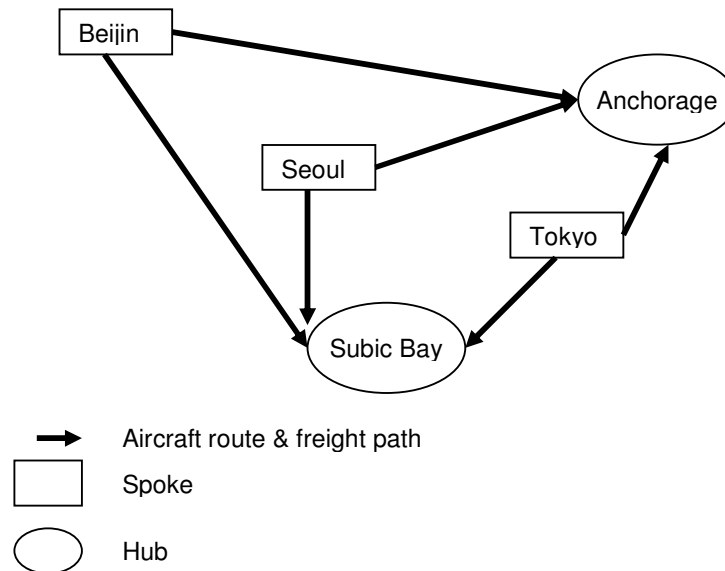
and departing aircraft within a time window (Berdy, 2002). A “window” is the length of time that airline planners have created for the bank to actively transfer passengers (Berdy, 2002).

Classification of hub and spoke networks

According to C.C, Y.J & D.Y Lin, there are three basic types of hub and spoke air networks that can be considered. However, this classification is theoretical and the boundaries between the models are blurred in reality. The case of multi-hub networks is not considered by Lin but this structure occurs when an airline seeks to serve a large market. The hub is then located in order to maximize the market penetration, minimise the length of hub to spoke connections, and avoid high levels of congestion at the central hub (Button, 2002).

- ***Pure hub and spoke networks***

Air centres and hubs are connected by air links. The pairs are operated between air centres and the hub but also between hubs. However, the direct pairs between air centres are not permitted as is shown in the figure below. As a result, all air cargo requires at least one re-handling at one at the hubs before going to its final destination (Lin, 2003).

Figure 5: Pure Hub and Spoke model ¹⁸

Within this model, two organisation types exist according to CC, YJ & DY Lin. In a single assignment hub and spoke organisation, air centres can only be connected by a single hub instead of the multiple assignments in which all centres are freely connected to several or all hubs.

C.C, Y.J and D.Y Lin present, in their paper, the main advantage for a pure single hub and spoke, explained in the past by Chester. “Re-handling at hubs is aimed at reducing the inefficiency associated with the direct flow of partial loads from pickup centres to delivery centres. A small increase in re-handling cost can significantly reduce the requirements for flight equipment, personnel and air miles, and other overall operating costs” (Lin, 2003).

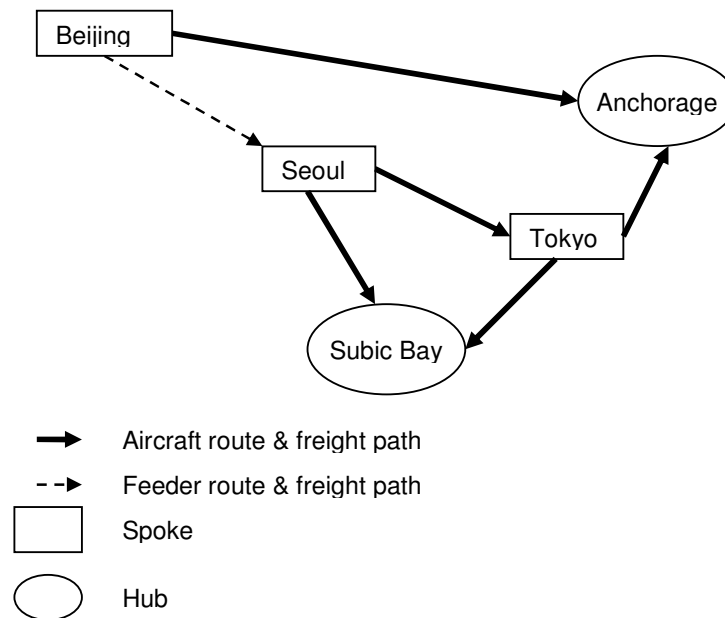
- **Hub and spoke with pickup stopovers and feeders**

In the case of low quantity of freight to collect at some centres, C.C, Y.J and D.Y Lin (2003) explain that express carriers sometimes use smaller aircraft, air feeders, stopping at a series of small centres in order to pick up additional shipments and fill up the aircraft before arriving at an air transit centre. Then

¹⁸ Lin, 2003

freight from the feeders is reloaded onto larger aircraft destined to a hub for consolidation as we can see in figure 6 below. Similarly, large aircraft may stop at other air centres on trunk routes for additional pickups before reaching the hub. Even though all shipments require hub re-handling, the use of pick up stopover minimizes empty hold space in aircraft and eliminates underutilised direct air centre-to-hub capacity.

Figure 6: Hub and spoke with pickup stopovers and feeders model¹⁹



• **Hub and spoke with centre-to-centre directs**

This consists of re-handling the shipments at intermediate centres. Therefore if desirable, the carrier can load and deliver freight from that centre, or transit freight may be unloaded from incoming aircraft and reloaded onto ongoing aircraft without further consolidation (Lin, 2003). An advantage of this system is that the carrier may feed some pickups directly from their points of collection to points of destination, avoiding unnecessary hub re-handling centre-to-centre direct cargo. Another advantage of the system is flexibility. It is possible for a carrier to respond dynamically to interim needs at stopover points allowing

¹⁹ Lin, 2003

carrying capacity to be used more efficiently (Lin, 2003). Indeed, for example, the express carriers have a possibility to postpone aircraft upgrade in case of an increase in traffic. However, this solution can produce higher consolidation costs due to the fact that shipments have to be re-handled at each intermediary point.

Finally, C.C, Y.J and D.Y Lin (2003) consider that the hub and spoke network with centre-to-centre directs is especially suitable for high density centres with low pickups within a relatively small geographical area.

- ***Hub selection***

Since cargo is not sensitive to routing and scheduling in the same way that passengers are, the criterion for freight hub selection differs from that of passenger hubs. Much cargo is moved at night and can use passenger hub capacity, free at that time, e.g. DHL at Cincinnati, (Button and Stough, 2000). Equally, similarly to FedEx, a cargo hub may be located at a city generating relatively low passenger traffic, which can represent a benefit due to less congestion. The integrated carriers' networks differ from passenger carriers in that they have a single large hub rather than multi hub interactive networks (Button and Stough, 2000). In the case of the European and Asian markets, the problem of Hub location is sensitive due to the competition between cities to become key hubs for international air transportation, according to Matsumoto (2007).

Chan (1994) has determined a series of factors in the assessment process for potential hub selection. Distance of transportation, travel time, operating cost, quality of cargo handling service, route authorisation and finally no flights curfew are the considered factors. Moreover, Chan (1994) has defined a series of rules for hub selection. Firstly, the hub location should be geographically central in relation to the market served in order to reduce "back-track" and to obtain a more uniform flying time between hub and spokes. Secondly, the airport should provide good facilities, offering an ample runway capacity and space for sorting facilities and equipments, during the required time slots. Thirdly, next-day

deliveries demand night operations and need slots available in the late evening (feeder flights from spokes to the hub) and early morning (delivery flights from the hub to the spokes). Fourthly, a hub requires space, eg the case of DHL in Leipzig. Finally, it needs good airport organisation in order to support a wave's coordination system between aircraft arrivals and departures (Chan, 1994).

Doganis and associates (1999) have defined a series of rules, to take into account when selecting a hub airport, more detailed and concerned by the European situation. Firstly, the proximity of the airport to business centres and industrial activities is sensitive. Secondly, in order to ensure delivery service to delivery depots with less costly road transportation, the hub needs to be located within an area 5 hours away by road transport to as many major cities as possible. Thirdly, the airport needs to provide sufficient runway length, both for flights to the further destinations of Europe and for non stop flights by large freighter aircraft to other intercontinental hubs in North America and Asia. Fifthly, 24-hour operation is vital and the airport should be able to handle large numbers of aircraft arriving and departing in a short operational window between 2400 and 0100; departure between 0200 and 0300. Finally, the airport should be able to provide (Doganis and associates, 1999):

- A large apron area
- Space for construction of a major sorting centre
- An adequate supply of labour in its locality
- Customs facilities
- Fuelling facilities
- A low rate of diversions due to poor weather
- Ready access to the principal highways of Europe

Gardiner's (2006) key findings have been considered to complete the list of factors influencing airport selection. He reports several factors not indicated above such as strong origin-destination market required, bad weather record acts, good road access to the airport and the speed of customs throughput at an airport.

- **Hub classification**

The initial usage of the word “hub” in the air transportation industry was designated by the Civil Aeronautics Board and continued by the FAA. This definition does not consider the airport as a transfer but used the term to categorize each hub based on its share of the total number of revenue passengers boarded in the country (Ivy, 1993). The term “Large Hubs” represented airports with at least 1% of total passengers. “Medium hubs” include airports processing between 0.25% and 0.99% of total passengers and “small hubs” enplaning less than 0.05% of the nation’s passengers (Ivy, 1993). Later, another way to classify the airport as a hub has been developed by several specialists such as Burghout (2006). According to Burghout, in network analysis, hub classification depends on three characteristics: the size of the origin-destination market; the stage length of indirect connection offered and the geographical specialisation of the hub traffic. The different models determined by Burghout (2006) are shown in the figure below.

- **Size of origin-destination market**

This can be defined as the measure of passenger traffic such as travel origin or destination. These characteristics help to distinguish two different types of hub. First of all, the “traffic hub” is an airline hub using its potential as an origin-destination node for local traffic (Burghout, 2006). On the contrary, a way-port depends heavily on transfer traffic (over 60%). Way-port airports can be suitable for their geographical location and rely on the wave system to ensure maximal and seamless indirect connectivity (Burghout, 2006).

- **Stage length of the segment of indirect connection**

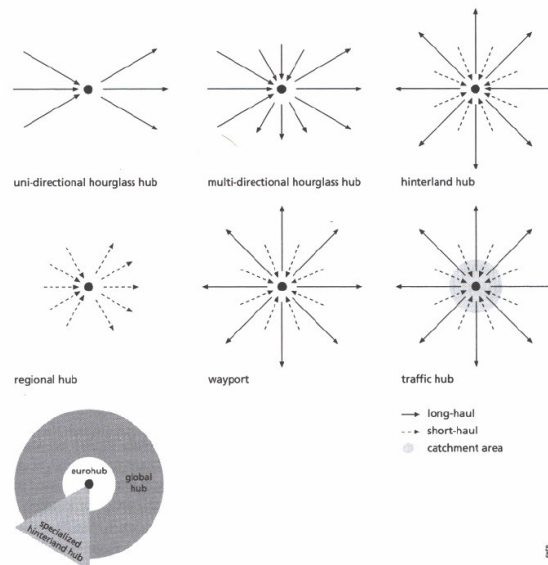
This characteristic allows the definition of four airport types (Burghout, 2006). First, the hinterland hub links international routes with short haul routes such as in the European Union, domestic European with intercontinental routes mix. Secondly, the directional (or hourglass) hub connects geographically separated regions located in opposite directions. This type tends to have unidirectional traffic i.e. east-west, south-north traffic and requires an excellent geographical position. The regional hub offers mainly short to short haul connections and

finally the all rounds hubs comprise all three kinds of connection (regional, directional and hinterland).

- **Geographic specialisation**

This part determines three kinds of hub according to the geographic specialisation of the traffic. In the case of a region, the hub can be specialised in intra regional traffic such as Eurohub for intra European traffic. A hub can also be specialised in a certain geographic area such as Madrid as in the Europe-Latin America hub. Finally the global hub covers the whole range of continental and intercontinental destinations.

Figure 7: Taxonomy of the different types of hub²⁰



²⁰ Burghout 2006

2.5 Chapter Conclusion

This chapter has confirmed the importance of networks in the airline industry and has noted that the basic role of a network is to connect nodes and to be economically reliable. The three components of a network (airline station, traffic node and hub) have been defined and the differences between passenger and freight air network operation have been stated.

Moreover, this chapter has presented the two-dimensional ²¹ approach of network analysis by Burghout and the different factors involved in the hub selection process have been reported.

Finally, the difficulties in classifying network configurations have been noted such as the weight in research papers of point to point and single hub and spoke network configurations. The hub and spoke network has been presented with its advantages and disadvantages but also its different models. In order to complete this chapter a classification of the different functions of a hub has been given to the reader.

²¹ Spatial and Temporal

3 The Air Freight Market

3.1 Chapter overview

Accounting for 1% of world air tonnage and 40% of trade value in 2006 (FedEx annual report 2006), the worldwide air freight market is broad and encompasses a wide range of shipments and products, from light documents to heavy general and specialist cargo that can be categorised by weight. Air express is only a component of the global air freight market (Doganis & associates, 1999).

The aim of this chapter is to give an overview of the intra-European freight market, considering particularly the CEP market. In order to carry out this description, the chapter is divided into 3 parts: the market, the demand and the players.

At the end of this chapter a series of conclusions are provided to the reader in order to underline the main points.

3.2 Air Freight Market Definition

Air freight is defined as the transportation of freight, mail and excess baggage²², according to the CAA (Keynotes report, 2005). It is relevant to consider the freight market as a multi-market involving multimodal transport “chain” in a multi-market air cargo network (Zhang et al., 2007).

According to the Major Ekman (2002), two characteristics of the freight market are relevant for network consideration. Firstly, it is expensive: “The reason for cargo to be shipped by air is very seldom related to transportation cost, as air freight, as a rule, is some ten times more expensive than shipping by lorry or ship” (Ekman, 2002). In order to justify the choice for air freight transportation, the shipper needs to find other factors to outweigh the disadvantage of cost,

²² passengers & air crews baggage

such as speed, reliability and security (Ekman, 2002). Secondly, it is easier than passenger air transport. “While passengers prefer to fly the shortest route between two points and not to transfer between aircraft, air cargo does not have any such preferences. Cargo does not mind night flight...” (Ekman, 2002).

Moreover, air freight is divided into two markets, the general freight market, mainly time-indefinite, and the express time definite freight market.

The general freight market

The general freight market includes all shipments using air transport but without a time definite transportation chain. These shipments are mainly carried by the traditional chain using airlines²³, freight forwarders and more recently integrators.

The express freight market

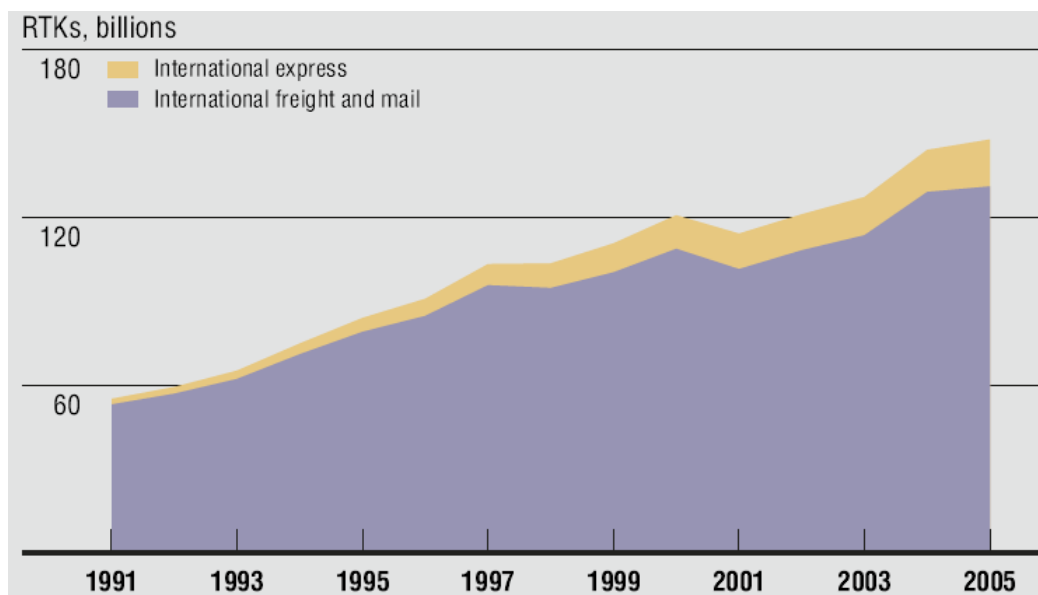
The Oxford Economics Group (2002) defines the express freight market. “The express industry core business is the provision of value added, door to door transport and deliveries of next day or time definite shipments” (Oxford Economic, 2002). The shipments covered by express transportation are mail, parcels and other items with a high value-to-weight ratio or a time-sensitive delivery requirement, such as spare parts (Keynote November 2005). Deliveries are mostly executed through an integrated network of transport facilities, integrating pick up, customs clearance, air transportation, delivery and so on (Doganis & Associates, 1999). Oxford Economics (2002) states that “To meet the requirements of business, the express industry relies on overnight transport, fully utilising the time from when a company hands over its shipment late in the working day to allow delivery early the next day”. Before going further in the market description, it is imperative to present the products forming part the CEP market. First of all, two product families are included in express transportation:

- Mail
- Parcel

²³ all cargo or combination passenger / cargo

Parcel comprises items that may be handled by one person without any special requirements. The characteristics of express shipments are time definite, high value commodities, high added value and low density (Oxford Economic, 2002). The express industry, born in the United States and developed since deregulation of air cargo services during the late 1970s, met a rapid expansion since this period (Oxford Economic, 2002). According to Boeing (Boeing forecast 2006) the market “has grown at more than twice the rate of total worldwide air cargo traffic”, with an average approaching 13% annually over the past decade as measured in revenue tonne-kilometres²⁴. The following figure illustrates this growth.

Figure 8: Evolution of express share within international freight market (1991 and 2005)²⁵



However, since 2000, annual growth has been slower at 6.9% as shown in the figure above (Boeing, 2006). As a proportion of total international air cargo traffic, international express expanded from 4.1% in 1992 to nearly 11.4% in

²⁴ RTK

²⁵ Boeing world cargo forecast 2005-2006

2005, reflecting higher-than-average annual growth as shown in the figure above.

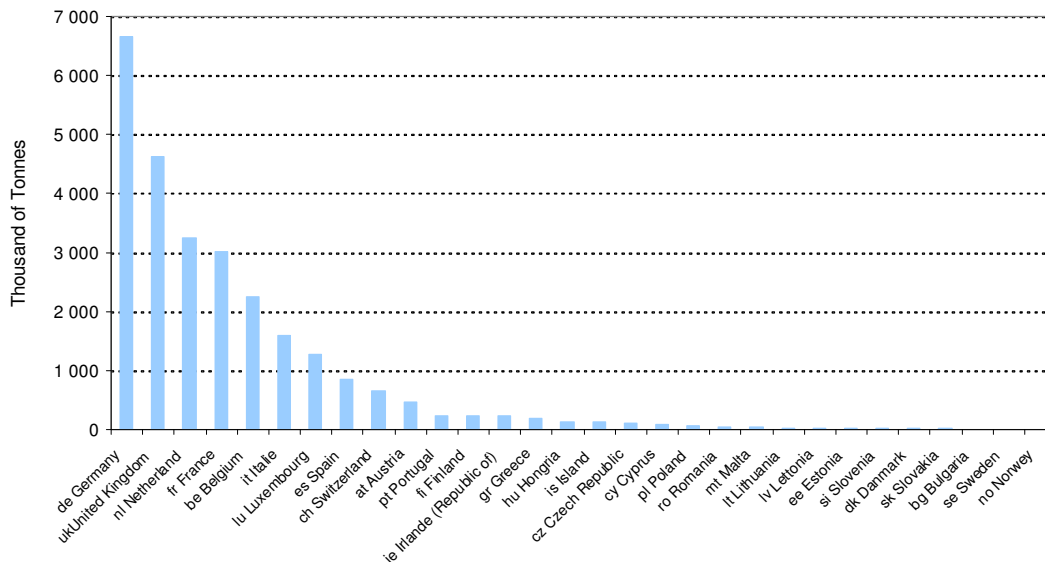
Kuby and Gray (2003) determine three factors influencing the boom of express package companies in the past. The fact that the developed countries have been more and more interdependent; innovation, i.e. computer and communications have particularly brought new solutions; and the application on the Air Cargo Deregulation Act of 1978 have highly influenced the development of express integrators.

The express industry is composed of many operators, from local based companies to international groups. The four main worldwide participants are DHL, FedEx, TNT and UPS, known as integrators.

3.2.2 The European CEP Market

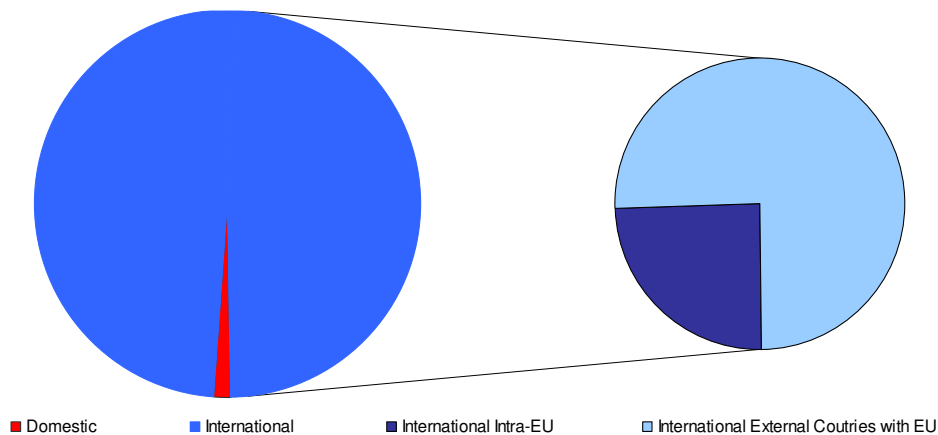
Three main characteristics can be identified in the European CEP market. The first particularity of the European market is the economic concentration on the northern part of the continent. “[...] leading markets are concentrated in the north European countries of Germany, France, the United Kingdom, the Netherlands, Belgium, and Switzerland [...]” (Boeing, 2006). This statement is confirmed by the traffic data from Eurostat (2008), presented by figure 9. Indeed, 20% of European countries stand for 81.42% of the Freight carried in Europe. Consequently, air cargo in this area is characterised by short length, (most of the sector lengths are between 900 km and 1200 km) according to Boeing (2006).

Figure 9: European air freight and mail transport by state, 2006²⁶



Another attribute of this market is the Schengen agreement signed in 1985, allowing the abolition of systematic border controls between the member countries. This decision, coupled with the relative small size of the national territories led to an intensive international dimension in the European Market. As described in figure 10, International traffic counts for 97.4% of the market. Within this segment, 24% is the share of the intra-European traffic.

Figure 10: European Freight and Mail Traffic split in 2006²⁷

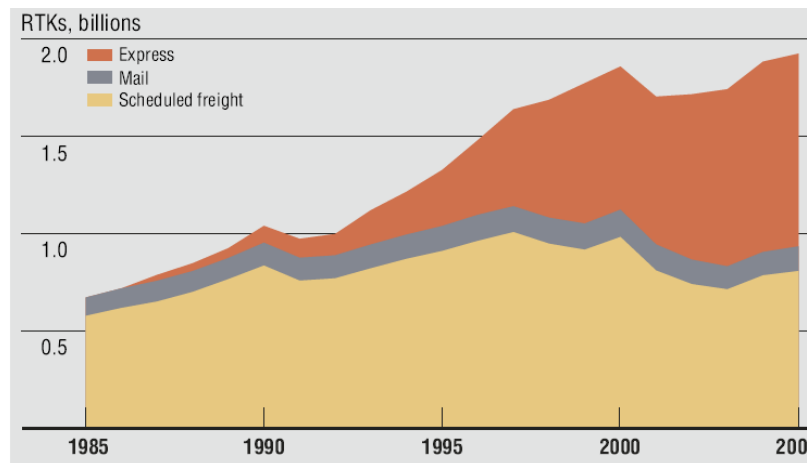


²⁶ Eurostat, 2008

²⁷ Eurostat, 2008

Finally, the third characteristic is the position of the Express segment of the market. As shown in figure 11 below, the express traffic influenced the rapid expansion between 1990 and 2000 of the intra-Europe air cargo market has met, with an average growth rate of 6% a year (Boeing, 2006).

Figure 11: The Intra-Europe Air Cargo Market between 1985 and 2005²⁸



This significant development is a consequence of a dual impact for Boeing. The first reason is the development of Express product offers, mainly through the development of Integrators' networks. The second one was presented above. The Shenghen agreement removed customs inspection on goods moving between several countries in northern Europe and resulted in road transportation expansion. Many air cargo flights are carried by lorries. However since 2000 the market growth slowed down to an average annual growth rate of less than 1% from 2000 and 2005.

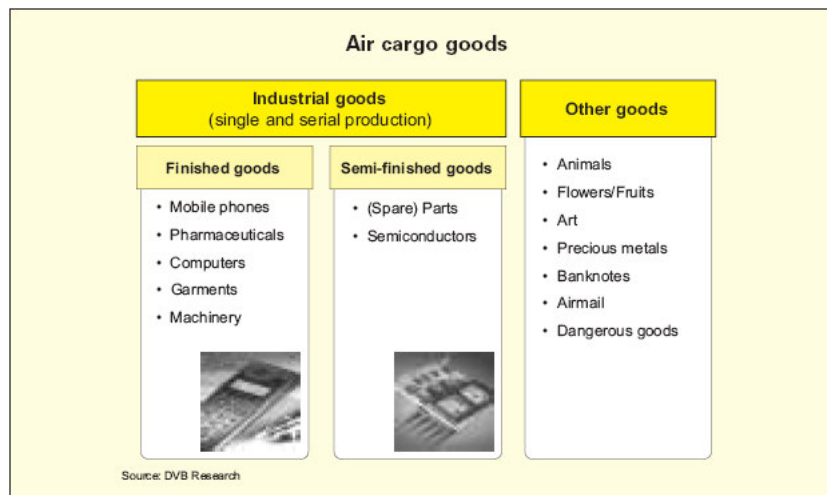
3.3 Demand

Used at the beginning for emergency transportation, the air cargo market has changed over time. Demand for air cargo looks for a rapid and secure means to transport shipments over long distances. Shipment value can justify the needs of such transportation. A shipment can be expensive or simply sensitive

²⁸ Boeing, 2006

for the shipper or consignee and air transport is secure compared to other means of transportation. However, the most obvious role for air transport remains the carriage of emergency freight, such as medical components and spare parts for machinery as shown in figure 12 below.

Figure 12: Air cargo goods²⁹



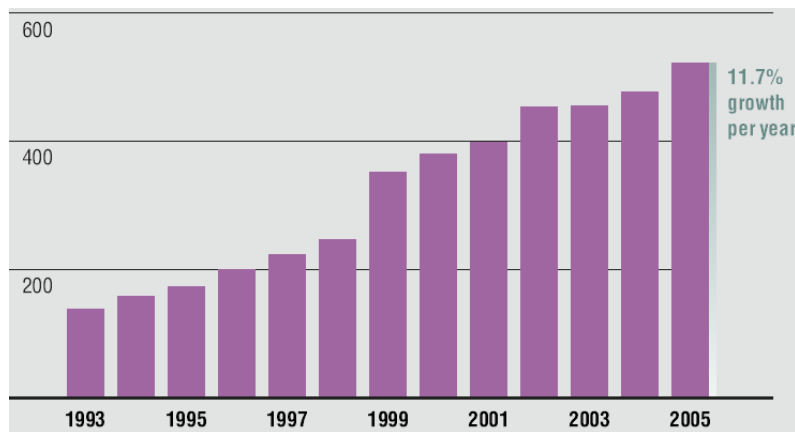
Three factors have considerably changed the air freight market since the mid-1980s: globalisation, supply chain management and information technology evolution. Globalisation has developed new geographical markets and increased the distance between consumer and producer. The phenomenon, coupled with the development of logistics practices and particularly supply chain management has developed a real need for regular effective and secure intercontinental transportation. The “Just In Time” model requires even more rapid and effective transportation chains due to a severe reduction of stocks. Finally, information technology development and particularly the internet have changed the market. Primarily, a threat for courier business due to the development of electronic mailing, it has been a real opportunity to develop private business. Indeed, the internet has driven the development of e-commerce, requiring worldwide parcel transportation for households. Moreover

²⁹ DVB group, 2001

with the development of the express business, the yield has been pulled down, making this service more and more affordable.

Since the beginning of the 1990's, the express demand has met a rapid development in Europe and the number of daily shipments carried has grown at an average of 11.7% a year over the period 1993 – 2005 as presented in figure 13 below.

Figure 13: Estimated daily express shipments in thousands between 1993 and 2005³⁰



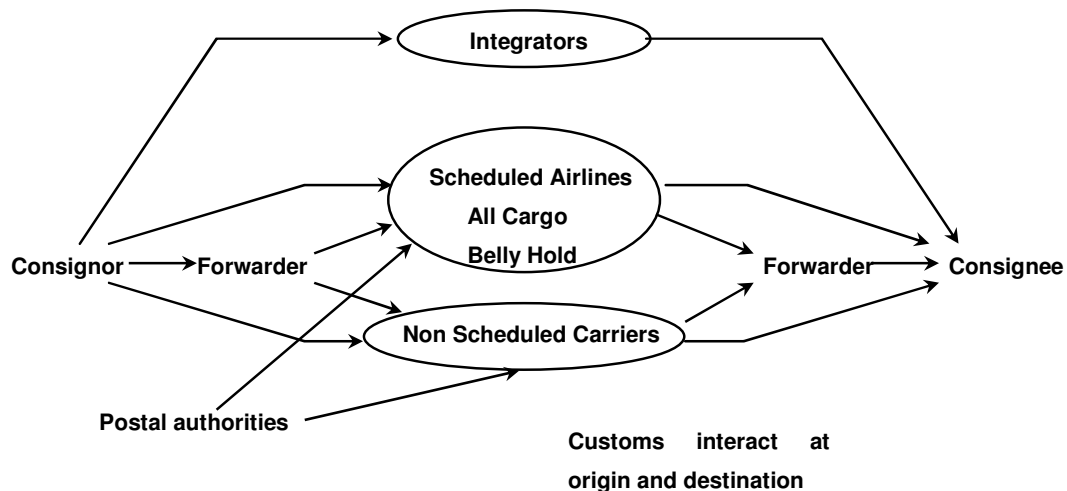
3.4 The players

Preceding the integrator's model creation, only one transport chain was present in the air cargo market, called nowadays the "traditional air freight chain" (Zhang et al., 2007). This model is based on the relationship of freight forwarder – airline where airlines are in charge of the transportation "airport-to-airport" as shown in the graph below (Zhang et al., 2007). The rest of the transportation chain is handled by the freight forwarder which is also the sale agent. This chain shows an intensive relation between the agent and airlines. According to Cancy and Hoppin (Zhang et al., 2007), 80% of airline air cargo tonnage uses freight forwarders, particularly with recent changes toward third party operators.

³⁰ Boeing, 2006

According to Button and Stough (2000), three main categories of cargo operators can be considered: the lines operators, the niches carriers and the integrators. However, it is relevant to note the key roles of freight forwarders in the transportation chain.

Figure 14: Air cargo transportation chain³¹



3.4.1 The lines operators

The lines haul operators manage the transport airport-to-airport and rely on Freight Forwarders for the rest. This category is composed of “All cargo carriers”, (scheduled and non scheduled) offering relative high reliability and capabilities to move large volumes over long distances (Button and Stough, 2000). In the past, several line operators have tried to challenge integrators by offering integrated products such as British Airways (only airport to door), Cathay Pacific, Singapore Airlines, and Swissair mainly in collaboration with freight forwarders (Chan, 1994).

³¹ *Introduction to Air Cargo*, presentation by P. Morrell on October 2006

3.4.2 The niches carriers

The term niche operator, according to Doganis (2002), defines a variety of scheduled and charter all-cargo carriers smaller than lines operators and operating within a particular region such as Emery Worldwide or Polar Air cargo. Niches carriers are mainly geographically specialised except some specialised in a particular product, eg super-size or super-heavy fret.

3.4.3 The Integrators

The carriage of express is generally done by integrators. At present the international air express market is dominated by four players, known as the “big four”. Indeed, integrated carriers are specialised in time definite carriage and express shipment of courier and parcels. “The term integrator refers to the ability of these companies to offer door-to-door integrated services” (Oxford Economic, 2002). The benefit of this vertical integration is a smooth transition from one mode to another and an efficient service (Ekman, 2002).

Moreover, integrated carriers offer a variety of products to shippers and supplement air services with extensive ground transport to provide time definite delivery with continuous shipment tracking and, if necessary logistical expertise to support “Just In Time” inventory control strategy (Button and Stough, 2000). Regarding the type of operation achieved (night flight), integrators operate quiet and reliable aircraft. Integrated carriers’ fleets have low utilisation levels (only light flights, in some cases only 2 hours per day). Integrated carriers, for economic reasons on the cost side and market presence on the demand size require large operations. For instance, DHL express, in 2006, employed 124,280 people and operated 420 aircraft (DPWN, 2006). To summarize, Chan (1994) has determined the characteristics of the integrator business:

- Service accessibility with smooth and simple processes.
- Only one responsible and contact with intermediaries.
- Premium rate guaranteed by highly valuable time definite integrated service.
- Standardisation of the processes and packages.

- High degree of branding awareness.
- Use of dedicated resources to ensure reliable service but involving high operating costs.

Heavy investment in specialised equipment which induces economies of scale is a major target and a major supporting reason for the use of hub and spoke networks.

Night operation (particularly for next day deliveries) means that quiet and reliable aircraft are required and induce a low utilisation of the resources.

3.4.4 Freight forwarder

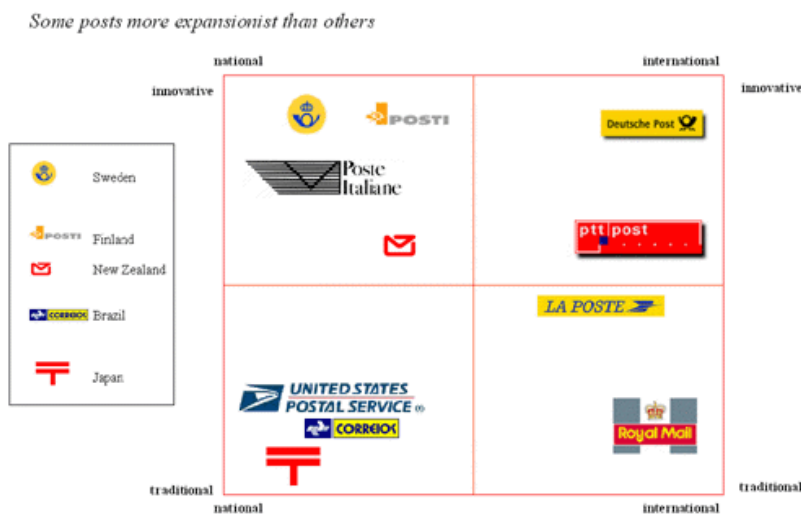
“Traditionally, a freight forwarder is defined as ‘an agent who arranges transport and prepares shipping documentation’ (Keynote, 2006). The Freight Forwarders represent the traditional air cargo chain when airlines and shippers relied on third party companies to organise pick up, delivery, warehousing, customs clearances, insurance and others services necessary for the shipment of goods. Freight forwarders were considered as the distribution chain of airlines. However those agents have to face the development of integrators’ products and the overall increase of capacity offered in the freight market. Freight Forwarders’ profitability has been reduced forcing major consolidation and mergers. In order to face direct competition from integrators, freight forwarders have pursue several strategies such as merger with airlines to create third party agent, partnership with airlines or integrators and even merger with integrators.

3.4.5 Post Offices

Post offices were national state owned companies in charge of postal and in some cases small parcel deliveries. Since the 1960s, national post offices have faced several challenges, such as privatisation, competition and decrease of market size. From the late century to the 1960s, national Posts were linked through the UPU, an international monopoly of international created by national post offices (TIACA, 2001). However, competition appeared, with first airlines and then integrators. Indeed, Federal Express and DHL Worldwide created at

this time a new time definite and more reliable document service, which appears to be a direct challenge to the postal monopolies. Since then Post offices have chosen different strategies to survive, particularly forced by the deregulation of domestic markets. “Post offices are being forced to become more international” (TIACA, 2001). “They are making defensive domestic acquisitions whilst expanding aggressively internationally” (TIACA, 2001), as shown in the figure below, presenting the different strategy chosen. Two dimensions have been taken into account, the degree of innovation to develop new products and the degree of international expansion.

Figure 15: Post Office market Strategy ³²



On the right are those post offices that have taken the decision to expand internationally. For example, Deutsche Post has invested considerably in order to build a major worldwide logistics group. DHL represents the major acquisition of the group. TPG (Dutch Post) have mainly focused their development on the couriers and parcel market with the TNT purchase (TIACA, 2001). On the innovation scale, Deutsche Post is also strongly present with the development of e-commerce services.

³² 2001, TIACA

3.5 Alliances and merging

The increase of the competition level within the freight market following the development of integrators has produced changes in the market with alliances and mergers between different players. Indeed, the market saw freight forwarders merging, freight forwarders merging with integrators³³, freight forwarders and airline partnerships³⁴, combination airlines entering the express door to door market thanks to a partnership with freight forwarders, shipping companies, integrators³⁵ and airline alliances, eg WOW and Sky team Cargo. Integrator alliances and acquisition will be developed in the next chapter.

3.6 Regulation

The regulation of air transport had a tremendous impact in both passenger and cargo activities. Even nowadays regulation brings constraints to the integrators strategies. Passengers and cargo air transport have met similar regulatory regimes. The Chicago convention of 1944 and the bilateral agreements have largely influenced the development of air cargo. The link between passengers and cargo legislation is also visible during liberalisation. So, the liberalization of the passenger market also applied to air cargo activities. Moreover, belly hold capacities on commercial flights are largely used in the freight market. So, passenger traffic regulation still influences cargo activities, particularly knowing the use of this capacity by some integrators (Button & Stough, 2000).

Furthermore, the courier market has some particularities. The first air cargo services were mainly for the carriage of mail. The transportation of courier was unprofitable and so direct subsidies were provided by governments to support them. A limited number of carriers could exploit these routes and so enjoyed monopolies. Monopolies in the courier market have been removed recently or

³³ DHL and Danzas

³⁴ Cargo 2000

³⁵ Lufthansa and JAL with DHL; Cathay and DHL for HK

remain present and so it has been a constraint of express market development in the world (Button & Stough, 2000).

Finally, environmental regulations, such as, noise emission control, fuel emission regulation or chapter 2 aircraft restrictions have an impact in cargo carriers' strategies. Regarding noise restriction, it is interesting to note, that the aircraft noise restriction agreed by the European minister of transport relates to two areas. First of all, the non addition of chapter 2 aircraft to EU aircraft registers after 1992 has been applied and followed by the ban on chapter 2 aircraft and engines after 1997 (Button & Stough, 2000).

3.7 Chapter Conclusion

This chapter has given to the reader an overview of the freight market, the characteristics of the European situation and express activities.

This chapter explains that the air cargo market is composed of general freight and express freight. The express freight market includes courier and parcel transportation. The features of the European market have been presented, particularly the economic concentration on the North West area or the integrators presence, accounting for more than 51% of freight carried.

Moreover, in Chapter three, the characteristics of demand in the air cargo market have been displayed.

Finally, the different players and their role in the market have been detailed as well as alliances and regulation.

4 Integrators' Strategy

4.1 Chapter Overview

The purpose of this chapter is to provide an overview of the past, current and future strategies adopted by the four integrators, particularly in the European market. The conclusions will be used to make assumptions on the structure of the different networks operated, in the following sections. For the purpose of this paper, the presentation will be more focused on the express segment. The chapter, covering comprehensively integrators' strategies, is divided to three parts. Firstly, an historical presentation of the company is followed by a description of integrators' market presence. Afterwards a review of integrators express business strategies will bring the reader to the conclusion of this chapter.

4.2 Integrators' presentation

The four main integrators have been founded in different situations and time periods. These origins have influenced past and current strategies. Consequently, it is relevant to bring to the reader's mind the integrators' origins and evolutions over time.

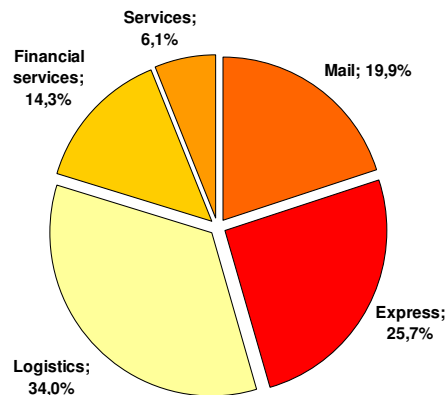
4.2.1 DHL

Founded in 1969, by Adrian Dalsey, Larry Hilblom and Robert Lynn, DHL specialised in personal documents shipping from San Francisco to Honolulu (DHL, 2005). The company grew up rapidly and started international expansion in 1971 (see annexes). In 1972, the network started serving Japan, Hong Kong, Singapore and Australia and in subsequent years, DHL launched services to Middle East, Latin America and Africa. In 1979, DHL extended its services to package deliveries as before that year only documents were shipped. 1983 and 1985 were very important years for DHL's network due to the opening of two hubs, respectively, Cincinnati in the USA and Brussels in

Belgium. Then, the non U.S. part of the company's operation was based in Brussels. In 1990, DHL made strategic alliances with Lufthansa and Japan Airlines. In 1993, DHL opened a new regional hub in the Middle East at Bahrain. In 1998, Deutsche Post became a shareholder of DHL. In 2002, Deutsche Post World Net completed a 100% shareholding of DHL. In 2004, the newly German integrator acquired Airborne to become the third US domestic express operator. Deutsch Post World Net operates in four corporate divisions; Mail, Express Logistic and financial services. The express and logistics divisions operate under DHL's brand. DPWN Mail Corporation Division is the largest postal company in Europe. In 2004, DHL reinforced its presence in India acquiring 68% in Blue Dart, the premium domestic courier and integrated air express package distribution company in India (DPWN, 2007).

Nowadays, the express division accounts for 25.7% of group revenue, as shown in the figure below, and produced €17,195 million revenue in 2006.

Figure 16: DPWN revenue by Division³⁶

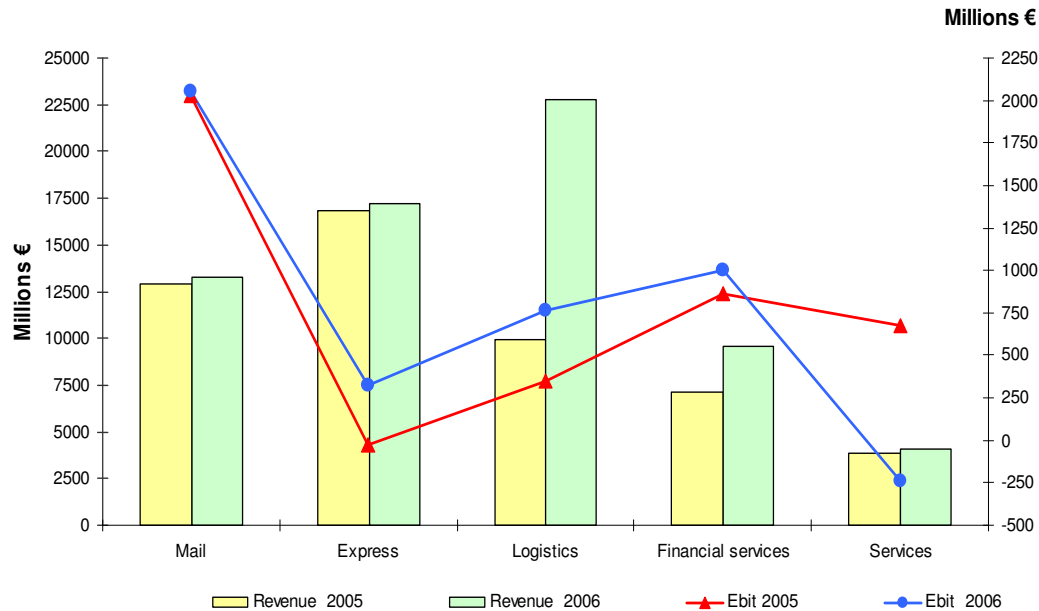


Since 2006, the express segment is the second activity of the German group, despite a revenue increase by 2.16% compared to 2005 as shown in figure 17. The express segment is the historic activity of the DHL brand but massive investment has been made on the logistic side recently. Moreover, pull down by

³⁶ DPWN Annual Report 2006

losses produced in the US market, the express division was slightly profitable in 2006 but the situation has improved compared to the losses of 2005 as illustrated below. During the last 7 years, this branch produced losses twice, in 2002 and 2005. The Express EBIT performances are the worst in the group in 2005.

Figure 17: DHL Revenue and EBIT performances by business unit³⁷



This situation is partly due to the nature of this business. Indeed, express business is capital intensive and requires heavy organisation throughout the world. In 2006, DHL Express worldwide employed 124,280 staff, operating at 36 hubs³⁸ with 72,000 vehicles and 420 aircraft³⁹ (DPWN, 2007). Another reason is the situation of DHL express in the North American market and will be explained later in the market presence part.

³⁷ DPWN, 2006

³⁸ In this case the term hub is broad.

³⁹ operating for DHL

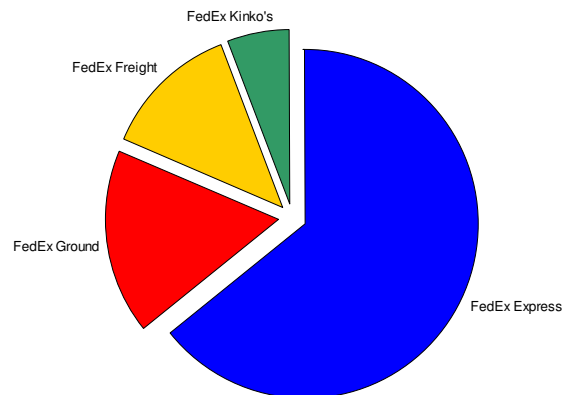
4.2.2 FedEx

Founded in 1971 by Frederick W. Smith, Federal Express really started its development in 1973 at Memphis Airport, the company's main hub today (FedEx, 2007). Federal Express was a pioneer in the express transportation of documents and small parcels not heavier than 30 kg in 1973 (Chan, C 1994). The company operated originally a fleet of Falcon 20 and was the first cargo airline using jet aircraft. In 1977, the deregulation of the US domestic market appeared as a real driver for the company's growth. Since this event the company was able to operate larger aircraft such as the Boeing 727 and McDonnell-Douglas DC-10 and so expand its operations. Intercontinental expansion began in 1984 with services to Europe and Asia. In 1988, the company launched direct scheduled cargo services to Japan. 1989 was an important year for FedEx expansion with the acquisition of Tiger international in February.

Nowadays, the company is a major international group, mainly active in CEP and Freight markets, at both domestic and international levels. The express division produces 64% of FedEx Group's revenues and 59.7% of group incomes as described in figures 18 and 19. While its core business remains express, it also offers traditional air freight services, same day and deferred deliveries, as well as warehousing and logistics, either integrally or through one of its sister companies. The group is present in four business segments: Express, Ground, Freight, and Kinko's⁴⁰. The four segments are managed as independent companies by the group.

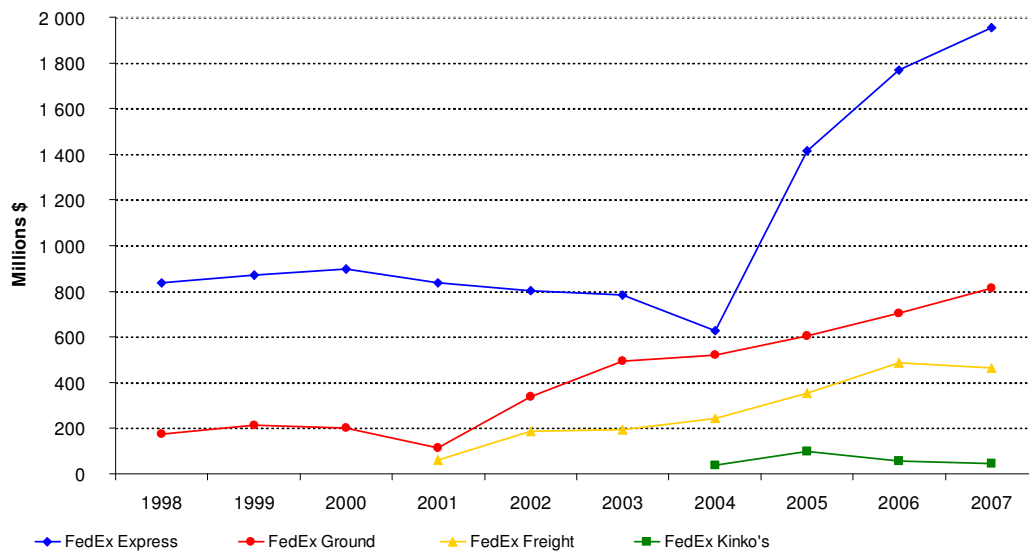
⁴⁰ Office and Print services

Figure 18: FedEx 2007 Revenue split by business segment⁴¹



Despite the expansion in new business areas, the American integrator continues to develop its express segment. Indeed, FedEx Express' revenues grew since 1998 at an annual average of 7.1% and show a steady development. Moreover, this branch is the most profitable. FedEx Express produces 59.7% of the group operating incomes. Operating incomes increased by an annual average of 13.4% since 1998 and 21.1% during the last 4 years as presented in figure 20.

⁴¹ FedEx, 2007

Figure 19: Operating income evolution by business segment⁴²

This division operates in two different segments of the express business: express packages and express freight. FedEx Express has an extensive air and ground network, delivering on average 3,265,000 packages everyday, in order to operate at an international level.

4.2.3 TNT

Established in 1946 by Ken Thomas, the company saw a rapid growth during the 1950's in Australia, its home market. Since this period, the company has offered overnight express products and services, using surface transport such as road and rail transport. During the 1970s and 1980s, the company reached into new markets and expanded internationally, particularly in Europe, North America, and Brazil. The creation of the single market in Europe at the beginning of the 1990s⁴³, allowed TNT to develop its European network. Indeed, TNT purchased a fleet of BAe 146 freighters and created the first pan-European overnight express service. The rapid development of the company in the European market, using company acquisition, put TNT in financial

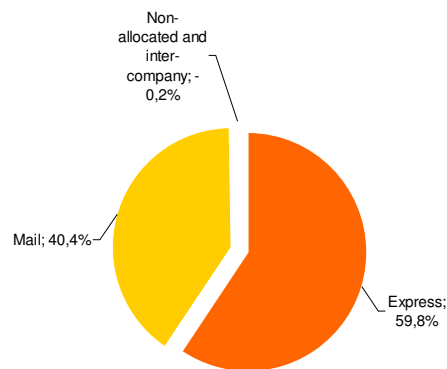
⁴² FedEx, 2007

⁴³ 1992

difficulties. At the same time the Dutch Post KPN, a national provider of mail, express and logistics services, developed from PTT Post, started its expansion in the international express market. In December 1996, KPN took over the Australian group. After that, a long period of integration was necessary for the group and several outside core-business activities were sold. Since the conclusion of the recent logistic branch sale to Geodis, the group has been focused on two business segments: mail and express.

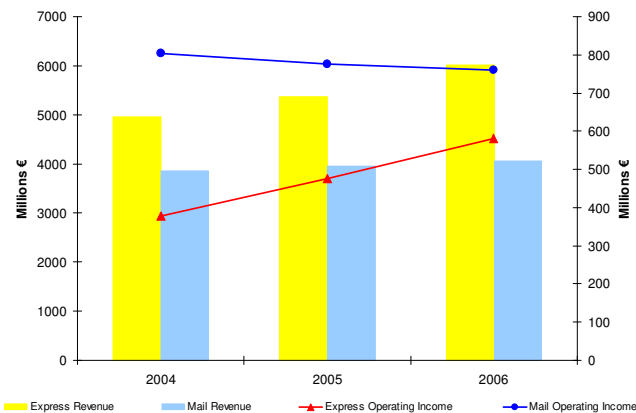
The express activity is the main business of the Dutch group in terms of revenue. Indeed, in 2006, the express segment accounted for 60% of group revenue.

Figure 20: TNT NV revenue split in 2006⁴⁴



Moreover the TNT Express is also expanding faster than the mail branch. This is partly due to investments in this sector in different geographic places as will be discussed later. Since 2004, the latter business expanded by 21.12% instead of the 5.53% seen for the mail segment. The number of consignments carried has grown by 16% between 2002 and 2006. However, the Express business is not as profitable as the mail one. Despite a strong increase of 53.44% between 2004 and 2006, it produces only 40% of the group operating incomes as described in figure 21.

⁴⁴ TNT, 2006

Figure 21: Express and Mail operating performances⁴⁵

Another particularity is that TNT express' activities are more focused on domestic and intra-regional markets in Europe and Asia than on intercontinental business but this will be developed later. According to the Dutch company, the biggest express markets are domestic.

4.2.4 UPS

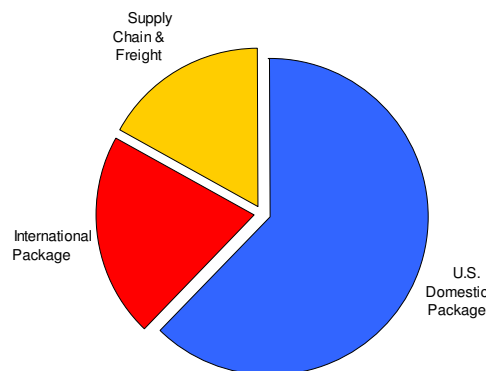
Founded in 1907 by James Casey, the company started with private messenger and delivery services in Seattle. At the beginning, the company was called American Messenger Company. Over the time, the company changed business segment and began focusing on the parcel delivery business, first in Seattle and then on a domestic scale. Indeed, in 1919 the company expanded beyond Seattle and changed its name to become United Parcel Service. In the early 1980's, the company started to run an airline in order to support its new expansion internationally. The first European services started in 1976 (Germany). Over the 1990's, the group invested in different business activities such as finance, logistics, customs, freight movement, electronic commerce and venture capital. Despite these developments the group primary business remains time definite deliveries of packages and documents.

⁴⁵ TNT, 2006

The story of UPS in Europe really started in the middle of the 1980's, when the company launched its first European operation in Germany. Following this investment, UPS decided to build its own European network and had purchased, by the middle of the 1990s, parcel companies in all EU countries (TIACA, 2001). Nowadays, the company operates its European air hub at Cologne/Bonn and has European headquarters based in Brussels. UPS operates 150 intra-European flight segments and 133 intercontinental routes, from its hub at Cologne-Bonn Airport. The Worldwide network operates 268 flights with in-house aircraft and charters a further 309 flights (Department of Air Transport, 2005).

UPS business is segmented into three divisions: Domestic package, international package and Supply chain & freight. Consequently, it is not possible to determine the performance and the size of the express business within the group. It also means that, contrary to the other integrators, UPS is sharing common facilities between the different services. The main business segment is clearly the US domestic package weighting 62% of group operating revenues. International package is second with 21%.

Figure 22: UPS revenue split by business segment⁴⁶

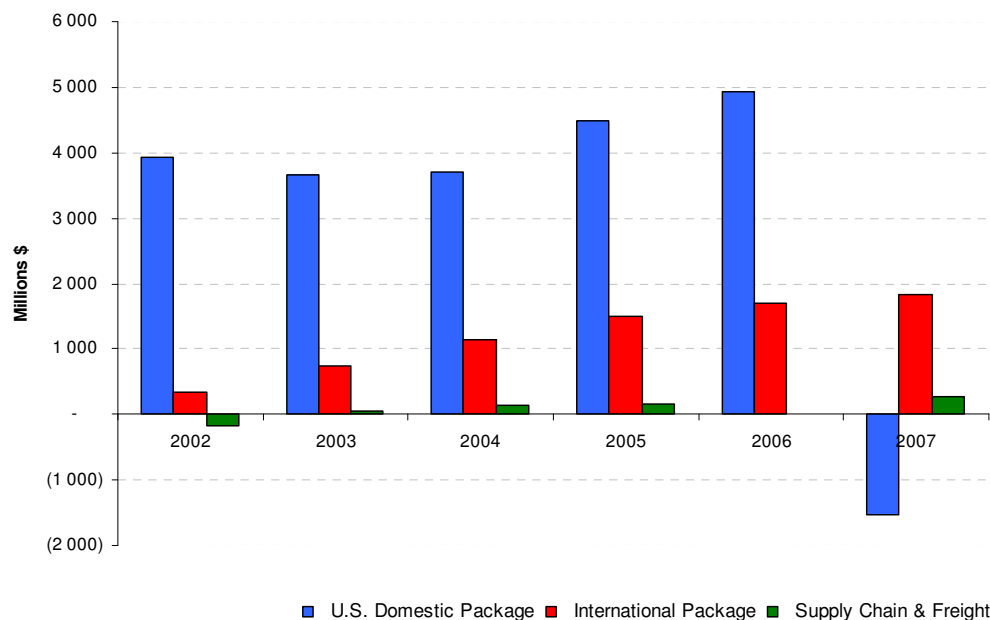


However, over the past 6 years, UPS Supply Chain & Freight and UPS International package saw a significant increase in revenue; respectively by 271% and 118%, but UPS Domestic Package grow only by 28%. One of the

⁴⁶ UPS, 2007

reasons explaining this trend is the maturation of UPS core market, the US domestic market. Another reason is the importance of the investments done on the Supply Chain and the international packages sides. Moreover, figure 25 illustrates the operating profit evolution through the different business segments. It shows the dominance of the US domestic business, accounting 74.2% of group operating profit in 2006, compared to 25.8% only for international package. However, the international business profits grow more rapidly⁴⁷. In 2007, the domestic package segment produced significant losses, mainly due performances in the last quarter of the year.

Figure 23: Operating Profit evolution per business segment⁴⁸



In conclusion, UPS is trying to develop its product range in order to face aggressive competition in the CEP market.

⁴⁷ + 442% between 1998 and 2007

⁴⁸ UPS, 2007

4.3 Market Presence

Network strategies were dependent on commercial strategies in the past. Hence, it is relevant to describe the market presence geographically but also in term of business segment before analysing the current networks. This part presents Integrators' market position in the different geographic areas: Europe, North America, Asia and the emerging market. Integrators' business needs to be analysed through a worldwide perspective, as strategies selected in a specific geographic area are consequences of market situations in other parts of the world. This is the reason the situation in North America and Asia are also described. For the purpose of this study, the CEP market only will be considered.

4.3.1 Europe

According to DPWN the European CEP market was worth €27.5 billion ⁴⁹in 2004.

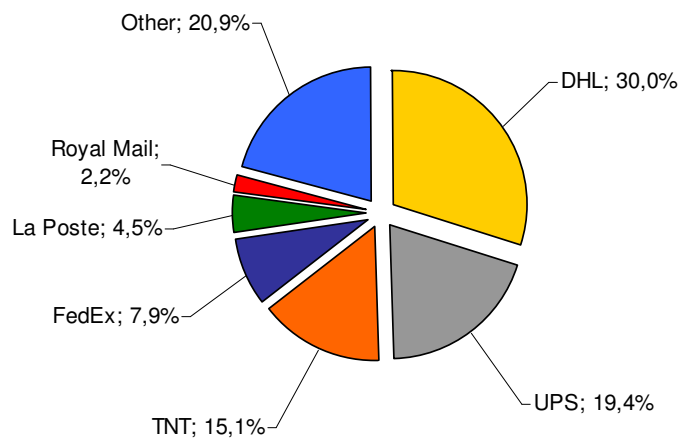
Over the years, parcel alliances and public postal operators have tried to penetrate the European market by acquiring parcel and express companies in order to create international air and road express networks. Europe has been the place of intense consolidation in recent years and now contains five major players with Deutsche Post (DHL), FedEx Corp. (FedEx), Geopost-Groupe (La Poste), United Parcel Service Inc (UPS) and KPN (TNT N.V) as presented in figure 24 below (TNT, 2006). Moreover, several alliances have been created in the market such as UPS with Poste Italian, TNT with Geopost, and FedEx with Geodis. Despite consolidation and alliances, the market is still more fragmented than in the United States (TNT, 2006).

⁴⁹ DPWN, 2005

DHL

DHL is the Europe largest provider of courier, express and parcel services, owning 30% market share in international express market to / from Europe in 2005, as shown in figure 24.

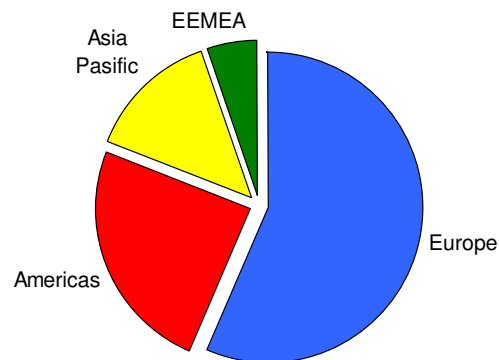
Figure 24: Europe international CEP market split in 2005 ⁵⁰(%)



Moreover, counting for 56% of DHL Express revenue in 2006, Europe is its core market and the company continues to invest in this area, as described in figure 25. The Express sector has benefited the Deutsche Post position in Germany, the leading European economy. Time definite services are performing well in the European market: pre-12 deliveries are available in 27 European countries, 74% of all business addresses in Europe and Germany (DPWN, 2006).

⁵⁰ DPWN 2006

Figure 25: Geographic split of DHL Express revenue in 2006⁵¹



FedEx

FedEx's position in Europe is weaker than its direct competitors. Indeed, the company is only the fourth operator of international express shipments to and from Europe in 2005 (figure 24) with only 8% of market share. However, fourteen years after FedEx withdrew its European market presence; the North American group decided to come back in the market with the bid over ANC holdings, a domestic express player in the UK (Air cargo News, 2007). The reasons for the drop during spring 1992 were on-going losses and a decision to focus on intercontinental services to and from Europe (Air cargo News, 2007). So far, FedEx has worked with Business Post in the UK market and will continue until the integration of ANC is completed. The current strategy of the American group is to reinforce its European presence, as illustrated by the acquisition of Flying-Cargo, a former Hungarian subcontractor.

TNT

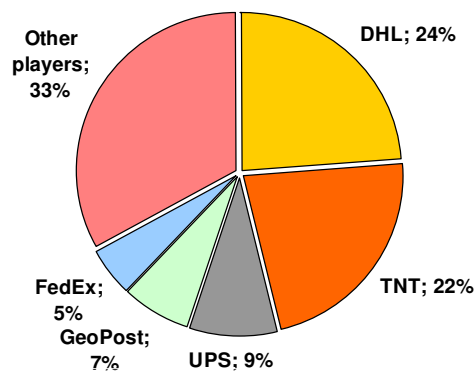
TNT express has developed over time an extensive worldwide network specialised in the CEP market. However, the network of the Dutch company is

⁵¹ DPWN 2006

considered weaker than its competitors, due to a lack of market coverage in the US as presented later.

In the intra-European and European International CEP markets⁵², the company benefits from a strong position. Second largest operator behind Deutsche Post group in the first market, with 11% market share (TNT, 2007), the Dutch group has an interesting third position in the second place behind DHL and UPS, with 15.1% (DPWN 2007).⁵³ Considering the narrow market, according to TNT's definition presented below, the Dutch company 's market share in Europe is about 22%.

Figure 26: Narrow European Market Split*⁵⁴

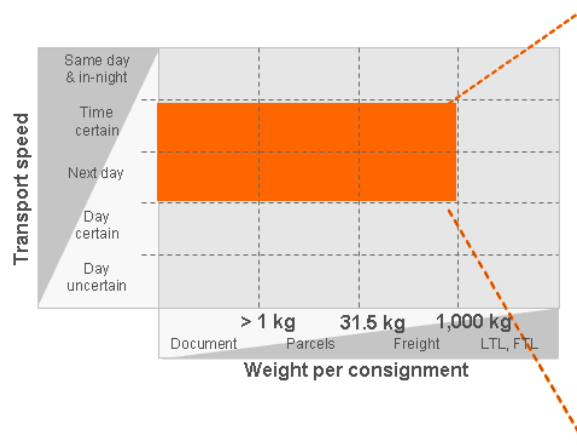


The narrow market is including the orange area in the figure 27, time certain and next day up to 1,000 kg.

⁵² Market Volume: €35 billion for the first and €7.6 billion for the second

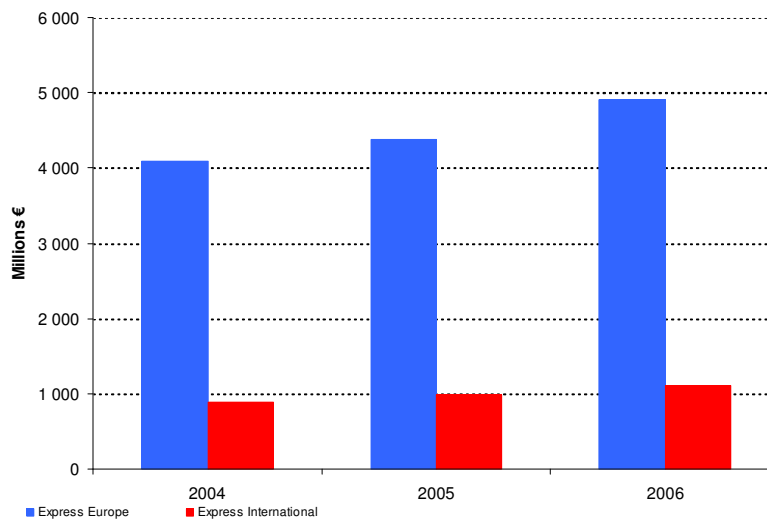
⁵⁴ TNT 2007

Figure 27: Narrow market presentation⁵⁵



Europe is the express division home market, where TNT offers express door to door deliveries of documents, parcels, and freight in 34 countries. Indeed, in 2006, the European market counted for 81.6% of the express revenues. However, the international revenue outside Europe grew more quickly, by 25.4% between 2004 and 2006.

Figure 28: Express revenues split by geographical area⁵⁶



⁵⁵ TNT 2007

⁵⁶ TNT, 2006

TNT express division tries to consolidate its European position through acquisition and organic growth. It acquired TG+, the Spanish largest domestic express company. In 2004, TNT started to invest €36 million to increase the capacity of its main air hub in Liege. TNT annual growth in eastern countries exceeds 20%.

UPS

UPS is the second largest operator in the international European market following DHL, accounting for 20%. This position is the result of a huge investment and long term position in the market started in 1976. The European headquarters are based in Brussels, despite having the hub in Cologne. The UPS European business area covers 57 countries. UPS's European export volume increased by 13% in 2006 compared to 2005⁵⁷. International volume to and from Europe increased by 12.4% for the year, due to volume growth in Canada and Europe, which also benefited from the acquisition of Messenger Service Stolica S.A. and Lynx Express Ltd (UPS, 2006). Indeed, the group has planned to reinforce its position investing in the expansion of its European hub, plus purchasing Stolica SA⁵⁸ and Lynx Express Ltd⁵⁹ in 2005. However, excluding the impact of acquisitions, international volume increased by 3.7% to and from Europe.

Finally, UPS employs around 32,000 staff in Europe, and has a fleet of more than 7,000 ground vehicles. It operates 150 intra-European flight segments and 133 on intercontinental routes, both centred on its hub at Cologne-Bonn Airport.

⁵⁷ UPS 2006

⁵⁸ one of the leading parcel and express delivery companies in Poland

⁵⁹ one of the largest independent parcel carriers in the UK

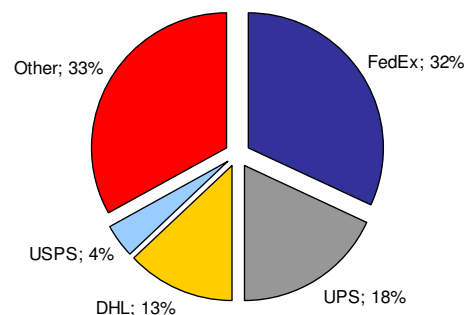
4.3.2 US America

The mature US market counts an estimated market volume of €44.8 billion⁶⁰ in 2004 which represents the main CEP market in the world. This strategic geographic place is dominated by FedEx and UPS but DHL has invested heavily to develop its market share.

DHL

Strategic target of the company for several years, the American market is the world's largest express market. DHL's presence in the market is justified by the globalisation and the guarantee of long business success in other markets e.g. US-Europe and US-China market. DHL provides domestic and international express services supported by an air and ground based transport network (DPWN 2007). However, DHL operations are small in the US domestic market compared to its competitors, with 13% of market share.

Figure 29: US International CEP market split in 2005(%)⁶¹



Hence, DHL Express has planned more involvement in the US domestic express market, as it is the world's largest market for express. It tries to achieve this with investments and acquisitions, accepting temporary losses from

⁶⁰ DPWN Annual report, 2006

⁶¹ DPWN, 2006

operating activities. Airborne acquisition in 2004 and Polar partnership reinforced its position (Oujamaa, 2006). In 2006, the American continents represented the second biggest express market for DHL, with a share of 24.5% of express revenues, despite an activity slow down between 2005 and 2006 by 1.95% as shown in figure 27.

FedEx

With a 32% market share in the US international CEP, FedEx express is the leader in this market. Using an extensive network, FedEx business, particularly in the express package and freight markets is both highly competitive and sensitive to price and service (FedEx, 2007). FedEx's main competitors are the other package delivery companies in the US domestic market, the other, namely ⁶², passenger airlines offering express package services, regional express delivery concerns, airfreight forwarders and the U.S. Postal Service.

In the USA, FedEx Express Packages offers overnight and deferred services of packages up to 150 pounds ⁶³ each. The service guarantees time definite delivery in one and three business days within the US.

TNT

TNT is not a major player in the North American market. The Dutch group offers CEP international services to and from this area, but on a limited scale compared to its competitors. Indeed, TNT provides international express services to and from the North East and the West coast, operating night transatlantic flights to New York in order to offer next day deliveries to 15 large cities (TNT, 2006).

However, TNT does not plan to invest in North America, considering the market mature, highly competitive and dominated by two major integrators: FedEx and UPS.

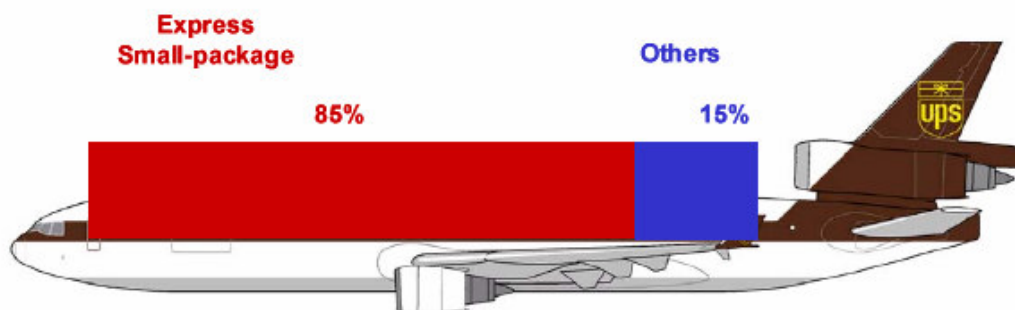
⁶² UPS, DHL

⁶³ 68 kg

UPS

Second largest operator in the international US market, UPS accounted with FedEx for 50% of market share, in 2005. The American integrator produced US\$47.5 billion in this market. Domestic Package services include time-definite delivery of letters, documents, and packages throughout the US. Next day delivery mainly uses air transport but also contains surface transport (UPS, 2006). UPS freighters carry mainly express small-packages on domestic routes. It accounts for 85% of the capacity as illustrated in figure 30 below. The other 15% contains freight, from both USPS and Global Freight Exchange (GF-X)⁶⁴. It is interesting to see that UPS also carries shipments for a competitor, USPS; however this has been a small amount up to now.

Figure 30: UPS domestic flight loading profile⁶⁵



4.3.3 Asia

The Asian CEP market met a rapid expansion in the last decade and benefited more recently from massive investment by integrators. This new strategic area influenced the evolution of worldwide and European networks.

DHL

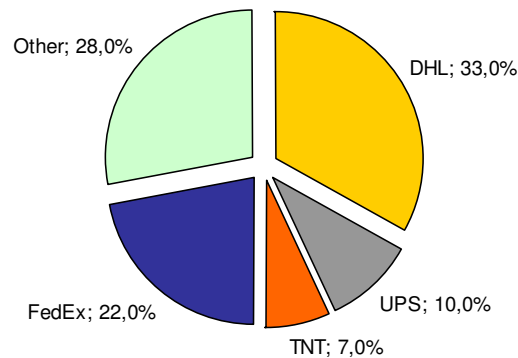
Accounting for 33% of market share in 2005 (see figure below), DHL is the largest operator in the international Asiatic market, a consequence of a long

⁶⁴ a cargo portal used by shippers

⁶⁵ Oujamaa, 2006

term positioning in this market. Indeed, with 6% market share, DHL is the largest international provider in the intra-Asiatic market, dominated by regional operators. The Asia Pacific market weights only for 13.7% of DHL's express business in 2006⁶⁶, but benefits from a rapid increase in the recent years⁶⁷. The strength of the DHL network is the result of strong partnerships built over time with Sinotrans⁶⁸, Transmile and Cathay Pacific. However, parcels market leader in Japan, Yamato Transport, ended its long-running partnership with UPS and launched its own international parcel service.

Figure 31: Asia International CEP market split in 2005(%)⁶⁹



In India, DHL Express has recently opened several new facilities, under the Indian subsidiary Blue Dart Express, and domestic air express market leader. Furthermore investing in facilities, the German company has expanded its network and capacity by introducing two Boeing 757 freighters that enabled it to offer 21 new routes (TNT, 2006).

⁶⁶ DPWN 2006

⁶⁷ DHL express' revenue in Asia Pacific increased by 12.94% between 2005 and 2006

⁶⁸ 20 years collaboration with the Chinese parcel operator

⁶⁹ DPWN, 2006

FedEx

Representing 22% of the Asia International CEP market in 2005, FedEx is the second largest player in this market. Moreover, the American integrator has decided to emphasise its development in the fastest growing market, Asia. It acquired its domestic Chinese business partner and the DTW Group for international connections.

This purchase will increase FedEx penetration in the Chinese domestic market. In India, FedEx took over its Indian service partner, Prakash Air Freight, and will be able to offer a portfolio of international and domestic express services.

TNT

Accounting only for 7% market share, TNT is the fourth largest operator in the Asia international market in 2005. However, the new TNT strategy for the next few years revealed at the beginning of the year is targeting this market. The strategy adopted by the integrator is already visible in Asia with the delivery of the first Boeing 747-400ERF ⁷⁰ and the acquisition of two subsidiaries, Hoau in China and Speedage in India (Air Cargo News, 19/01/2007). The future objective of TNT is to become China's largest road network operator offering comprehensive road coverage in 1,100 locations in China. TNT targets an annual 30% growth over the period 2006-2010. In order to comply with these objectives the company strategy is focused on two point. First, the company seeks to expand its international network between the country and Europe and secondly TNT develops an extensive domestic network. TNT flies a Boeing 747-400 ERF four times a week between Shanghai and Liege. The plane leaves China with a full payload and returns half full. Moreover, with the acquisition of Hoau, a road freight company, TNT benefits from a large domestic network.

⁷⁰ Entered in service the 18th January 2007

UPS

UPS is the third largest operator in the international Asiatic market. Moreover, the company invests heavily in this area. UPS increased Chinese connections up to 21 flights, including 9 weekly Shanghai-USA flights and 5 weekly Shanghai-Cologne flights (UPS, 2006).

4.4 Integrators' Express business strategy

Following historical presentations and geographic market presence description, the integrators' business strategies will be explained with a natural focus on the European area.

4.4.1 DHL strategy

Networks are considered strategically as a competitive advantage at DHL, specifically in the express branch as declared in the German group annual report (DPWN, 2006). "We intend to maintain and further extend our position in the highly-competitive express market. To do this we will require efficient transport networks that provide the capacity required to meet the exacting demand of our customers in respect of posting and delivery times". DHL strategy is visibly looking at its product portfolio, alliances and its fleet.

A very sensitive strategic decision has to be taken into account and will be further discussed in chapter 6. DHL has made the decision to move its central hub location from Brussels to Leipzig. This move is motivated by several transportation issues but also by strategic ones. Indeed, Leipzig airport benefits from a more central position in mainland Europe and a direct access to the growing Eastern Europe market. The benefits of this move will be discussed in chapter 6.

DHL express products

DHL express products focus on both companies and private customers to offer courier, express and parcels services via three product lines defined according to speed of delivery: same day, time definite and day definite deliveries. The

three product lines are provided to customers in each of the four geographic areas served by the German integrator, Europe, America, Asia Pacific, Emerging Markets (DPWN, 2006).

DHL Alliances

DHL has made in the past years a series of alliances in order to strengthen its network. One the main reasons explaining these partnerships results from the fact that DHL has elected not to follow UPS and FedEx strategies by investing in their own fleet of wide-body freighters, but have instead created partnerships with large cargo carriers to guarantee capacity (Air Cargo News, March 2007). Indeed, Becasse⁷¹ explained that investing in a proper aircraft fleet is not compatible with DHL's strategy. "The longer the flying distances are, larger aircraft are needed". DHL as an express carrier has the particularity to fly every day Monday to Friday. That means, in reference to the fact that a big freight aircraft has a capacity of 100 tonnes that the company has to find 500 tonnes per week to fill in the aircraft. It can result in an overcapacity situation for some routes and later driving a decrease in the quality of the service. Indeed time sensitivity will be affected by the need to consolidate enough freight to fly (Interview with J. Becasse, 3rd July 2007).

First of all, to strengthen its position in the international US market, DHL acquired, in October 2006, a 49% interest in Polar Air Cargo Worldwide. The German integrator also signed an agreement with the North American carrier over twenty years to guarantee DHL long term access to air freight capacities on trans-pacific routes. For Draycott⁷², the reason explaining this new agreement between Polar and DHL is due to a will of developing trans-pacific connections. There was an existing agreement between Northwest Airline and DHL to operate this route, but Northwest operated an old freighter fleet that needed replacement. Regarding the short and middle term, this agreement

⁷¹ Interview with J. Becasse on DHL's route network, 3rd July 2007

⁷² Interview with A. Draycott on DHL air route network in August 2007

would not change the US network structure despite an increase of capacity to the west coast (Interview with J. Becasse, 3rd July 2007). In the US domestic market, DHL Express is a major forwarder. DHL does not operate an airline for its US domestic air shipments, but has contracted an agreement with Astar and ABX. These two carriers operate the DHL domestic network using Boeing 727, A300 and Boeing 767 aircraft (Interview with A. Draycott August 2007). ABX Air was formed in 1980. The carrier was formerly a wholly owned subsidiary of Airborne Inc. DHL acquired the ground and related operations of Airborne in August 2003. DHL was not able to acquire the air carrier part of Airborne because of the US laws and DOT state that non-US citizens may not own more than 25% of a US air carrier. DHL is ABX Air primary customer. ABX Air revenues come from the ACMI and hub service agreement with DHL (Oujamaa, 2006). ABX Air provides only air transport within North America. Next day services are primarily transported by ABX Air aircraft fleet and are sorted through ABX Air's nightly hub operations. Through the hub service agreement, ABX Air operates and maintains DHL's primary US sort facility in Wilmington, Ohio. The Wilmington facility handles nearly one million pieces during every night operation for each weekday (Oujamaa, 2006). ABX Air has a freighter fleet of 119 freighters that contains Boeing 767s, DC-8s and DC-9s, all converted from passenger aircraft.

Secondly, since March 2006, DHL and Cathay Pacific have collaborated on overnight cargo/passengers flights on Hong Kong to Osaka, Seoul, Taipei and Singapore routes. The Cathay all cargo subsidiary Air Hong Kong (AHK) operating to several Asiatic destinations such as Tokyo, has been owned ⁷³by both companies since 2002.

Thirdly, an alliance is working between DHL, Lufthansa and JAL. 25% of DHL international is owned by JAL and Lufthansa shares and a strategic cooperation

⁷³ 40% by DHL and 60% by Cathay Pacific

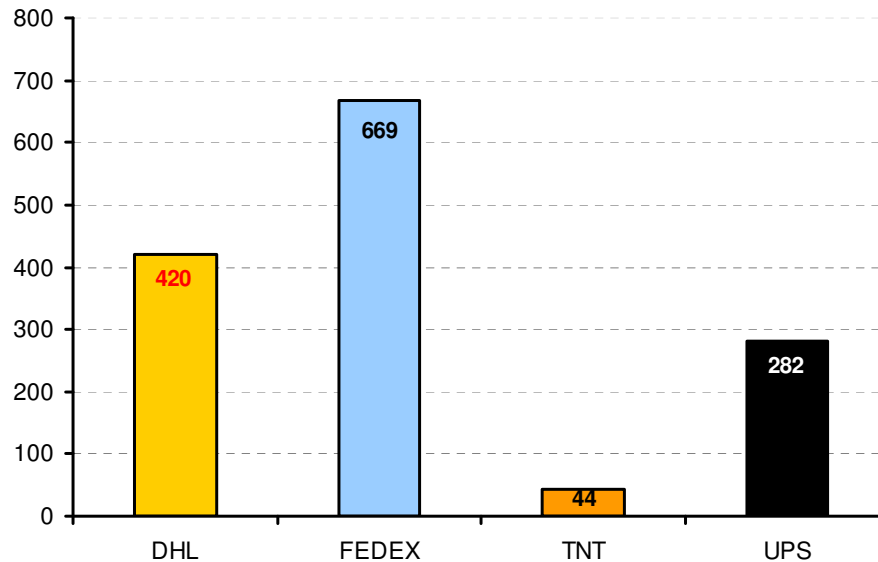
has been stated between the German groups on a joint operation on five international routes. In 2005, DHL formed a joint venture with Lufthansa Cargo called 'LifeConEx' based in Florida, offering a temperature-controlled specialist transport for pharmaceuticals, biotech and healthcare products (DOT, 2005). Moreover, according to the newspaper "Air cargo News"(March 2007), DHL and LH⁷⁴ are in negotiations to create a new partnership that could be even bigger than DHL's recent tie up with Polar Air Cargo in the US. Two other airlines were in competition to create this alliance, Emirates Skycargo and Cargolux

These alliances have a significant impact in the network strategy chosen. The first alliance aims to reinforce DHL's position in the market with a specialist carrier. For the second one, it allowed to strengthen DHL's service network in Asia-Pacific and to help consolidate Hong Kong as a key express logistics centre of Asia. The third alliance is seen as partnership with major carriers in order to associate in the transport chain and can be explained by the DHL fleet strategy.

DHL fleet

As presented in the figure below, DHL owns a large fleet. According to the graph DHL has the second largest fleet of the four integrators behind FedEx. However, compared to FedEx or UPS, DHL fleet is mainly composed of small and medium sized aircraft. In Europe, mostly three aircraft types are operated throughout the network, the Boeing 757 for regular links, such as BRU-LYS, the Airbus A300-600 on larger routes and the ATR 42 on feeder flights i.e. Brussels-Sofia as the routes not driving lots of freight.

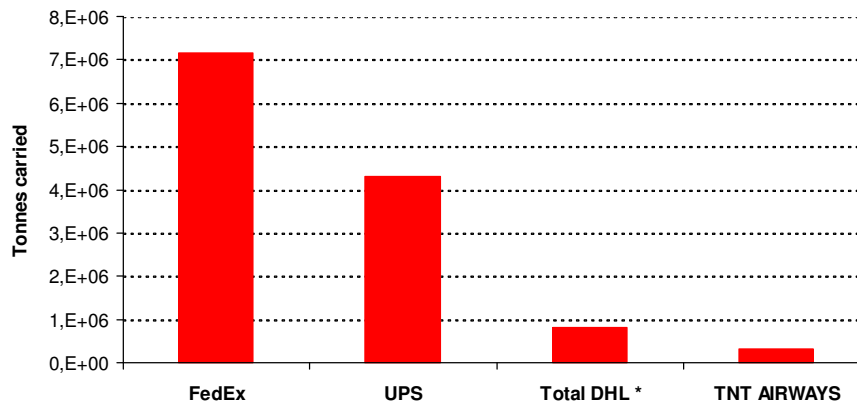
Figure 32: Number aircrafts per integrators' fleet



4.4.2 FedEx strategy

FedEx is not solely one of the main integrators in the world; it is also the biggest scheduled freight carrier both in term of tonnes carried and tonnes-kilometers in 2006. As presented in figure 33, FedEx carried over 7.1 millions Tonnes of shipments⁷⁵, 67% more than UPS, second integrator in term of freight carried. In 2006, FedEx carried 56.8% of integrators scheduled freight tonnage. This information illustrates FedEx's strategy. Indeed, the gap between the American integrator and its international competitor is mostly due to the result of two factors. First, FedEx express is the leading company in North America, the largest domestic CEP market, as shown previously. Secondly, the American integrators' past strategies has been focused on business integration. For example, it operates the largest freighter aircraft fleet in the world, which clearly demonstrates its strategy to realise the transportation in-house.

⁷⁵ IATA, 2007

Figure 33: Scheduled Freight Tonnes Carried by Integrator in 2006⁷⁶

*Traffic incl. EAT and DHL International EC

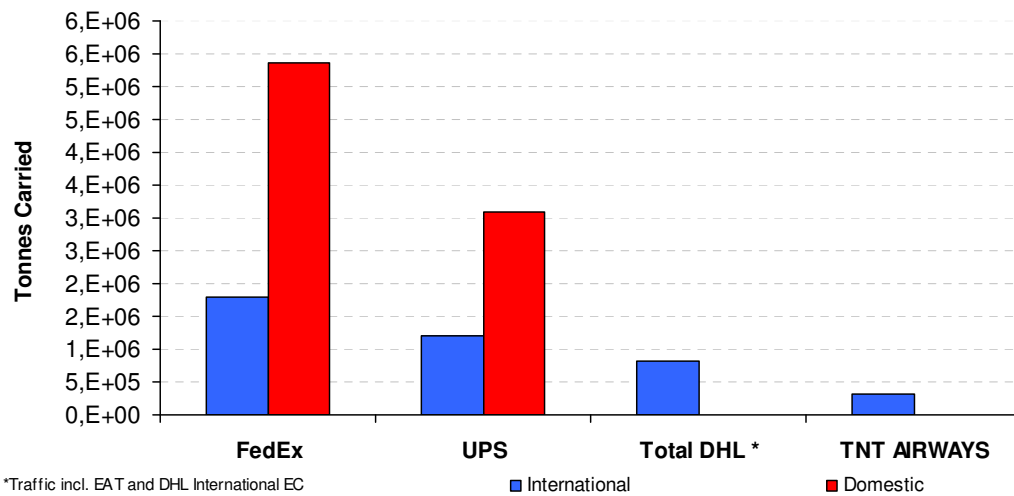
Recently, the strategic orientation of the North American integrator is focused on two points. First of all, the company plans to reinforce its position in the highly competitive US market, and secondly to invest in the main markets outside the US. The selected markets are Europe and Asia. The last demonstration of FedEx's investment in Europe is given by the acquisition of ANC holding. The British company is specialised in domestic road express business. The FedEx decision can be explained by a need for economies of scale to reduce the cost per move in Europe. This business is a potential driver for international traffic. "FedEx in Europe is like DHL in USA, they need larger operations in order to offer competitive products as it is a resource intensive business". However, this acquisition presents a potential risk as it will need a compromise between higher expectation of the customers and very low margins but also because there is a threat of customer retention. "FedEx's challenge will be to increase the volume in order to increase revenue and margins (Interview with A. Draycott in August 2007)".

Moreover, looking at the evolution of FedEx traffic presented in the figure 34 below, the domination of domestic business is clear. The domestic traffic share is the highest compared to its competitors with 75%. Operating mostly in the

⁷⁶ IATA 2007

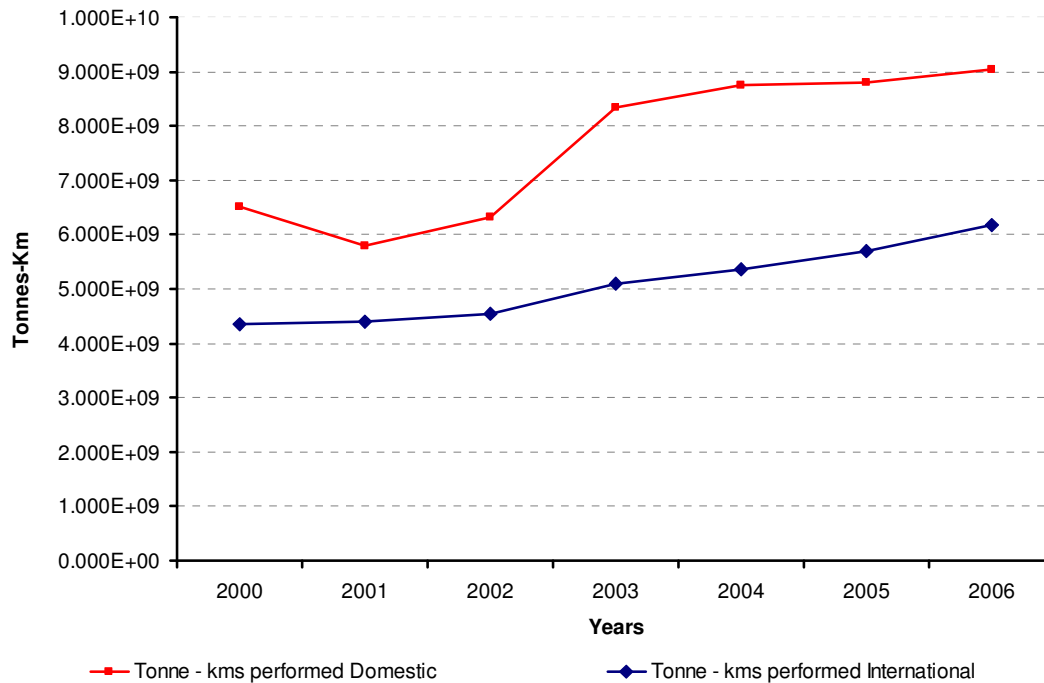
Intra-European market, EAT and TNT Airways have a very limited share of domestic traffic due to the size of the European countries.

Figure 34: Scheduled freight Tonnes carried split by integrator and traffic characteristic⁷⁷



However, looking at the trend in particular since 2003, the curve shows a faster development of the international business in the last five years which clearly proves its international orientation.

⁷⁷ IATA, 2007

Figure 35: FedEx traffic split between domestic and international⁷⁸

FedEx Aircraft Fleet

FedEx operates the largest freighter aircraft fleet in the world with 669 aircraft, (see figure below). Moreover, the company owns the largest fleet of wide-body aircrafts, with 264 aircraft. The aircraft mix is composed of the three aircraft class used in the market: small turboprops, small freighters such as B737, and large freighters eg D-11.

⁷⁸ ICAO data at <http://www.icaodata.com/>

Tableau 4: FedEx Fleet in 2007⁷⁹

Aircraft Type	2007
Cessna 208B	243
Boeing 727-200	94
Airbus A310-200/300	66
Airbus A300-600	60
Boeing MD11	58
Boeing MD10-10	49
ATR-42	29
Boeing DC10-10	14
Boeing DC10-30	13
ATR-72	13
Cessna 208A	10
Fokker F-27	8
Boeing MD10-30	7
Boeing 757-200	4
Boeing 727-100	1
Boeing 777F	–
Aircraft Fleet Total	669

FedEx Products

FedEx's services portfolio is presented in the table below. The North American carrier product is based on three types of services, "next day early morning", "next day", and "day definite".

Table 1: FedEx service portfolio in Europe⁸⁰

Intra European Services	
Service	Description
FedEx International Priority	Next Day Service Within Europe
FedEx Europe First	Next Day early morning delivery by 9:00, 9:30 or 10:00 am
FedEx 10 kg and 25 kg Box	Next Business Day
International Services	
Service	Description
FedEx International Priority	1-2 Business Days
FedEx Europe First	Before 8:00 or 8:30 am to destination across
FedEx 10 kg and 25 kg Box	1-2 Business Days
FedEx International Economy	4-5 Business Days
FedEx International Priority DirectDistribution	

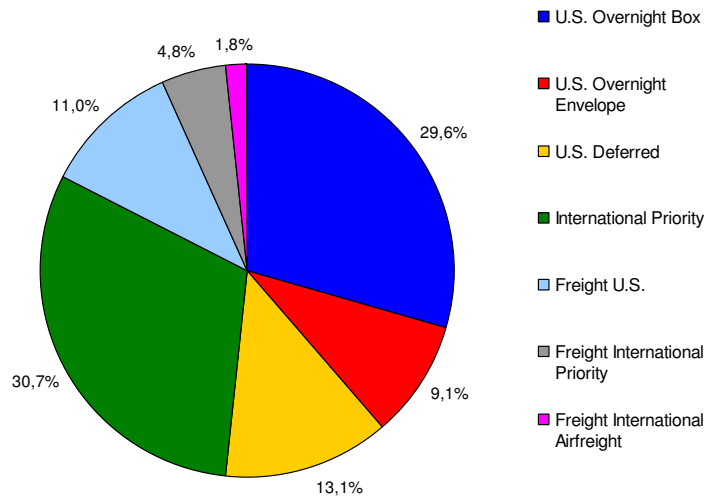
Looking at the performances of FedEx's main products shows a clear domination of the US market. Indeed, US overnight delivery accounts for 38.7%

⁷⁹ FedEx, 2007

⁸⁰ FedEx, 2007

of the revenues. However, it is interesting to realise that the main FedEx express product was in fact its International priority, with 30.7% of the express revenues in 2007. This information needs to be taken into account while analysing FedEx's network strategy, as it could be a factor influencing network design.

Figure 36: Express Revenue split between FedEx express products in 2007⁸¹



4.4.3 TNT strategy

Recently, TNT has defined a new strategic orientation in order to grow in the near future. The new strategy is named "Focus on Network". The first symptoms of this strategy are already visible and explain the current situation of the Dutch carrier. TNT's strategy will be presented under a different view through a commercial aspect first, followed by alliances and finishing with transportation.

Focus On Network

The new TNT strategy⁸² for the next years revealed at the beginning of 2007 by the company is focused on its network. The strategy adopted by the integrator,

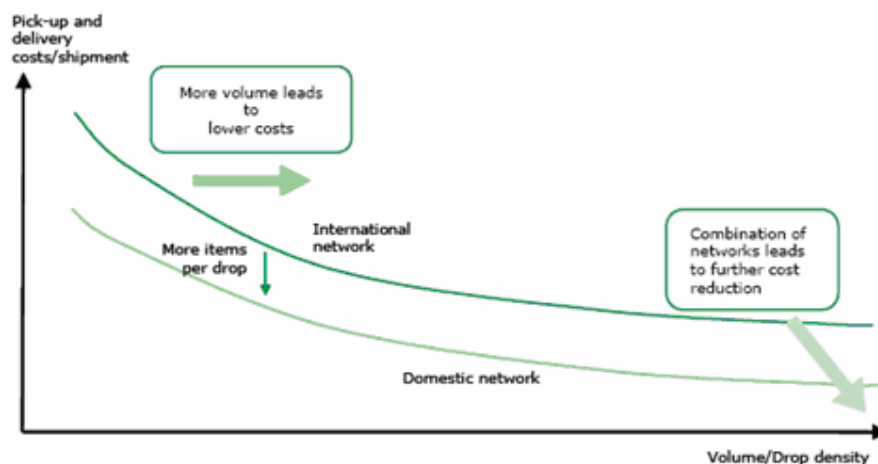
⁸¹ FedEx, 2007

⁸² "Focus On Network"

already visible with the delivery of the first Boeing 747-400ERF⁸³ and the acquisition of the leading Brazilian express company “Expresso Mercúrio”, is to develop its position in the emerging market (Air Cargo News, January 2007). Indeed, the new strategy is focusing on two points. First, the company plans to strengthen its position in the European market and secondly to invest in emerging markets in order to become the market leader in these areas as confirmed by the express managing director Marie Christine Lombard: “our strategic objective is to become number one in selected emerging markets” (Air Cargo News, January 2007). Several acquisitions illustrate this trend such as Hoau in China, Speedage in India and Expresso Mercúrio in Brazil. Moreover TNT is now looking at less developed markets and has decided not to go in the highly competitive American market such as DHL (Air Cargo News, January 2007).

The main objective of the company's strategy, illustrated in figure 37 below, is to make denser the international network in order to benefit from economies of scale. In 2005, only 20% of express revenue was produced by the international network against 80% in Europe (Abn Amro, 2005).

Figure 37: Pushing volume through the network⁸⁴



⁸³ Enter in service the 18th January 2007

⁸⁴ ABN AMRO, 2005

Another feature of its new strategy is the sale of its logistics branch in order to focus on the CEP market. According to ABN AMRO (2006), this loss does not make TNT weaker strategically. Operational synergies in Mail and Express can be an opportunity for closer co-operation and so economy of scale, particularly in the European Mail Network.

To conclude this section, the strength of the express branch of the group is a strong position in the European market and a growing business in Asia. The weakness could be the weak presence of TNT in North America. The threat of TNT at the moment is coming from the competition increasing capacity in its core market.

TNT Products

Similarly with TNT's strategy the company services portfolio also contrasts with its competitors. Instead of a "one stop shop" strategy, TNT's express division has chosen to focus on B2B express market. Moreover, contrary to FedEx or DHL strategies, TNT has decided to sell its logistic division in 2006. This activity no longer suited the company strategy. There were two main reasons explaining this decision (TNT, 2007). First of all, according to the Dutch company, there were few synergies between express and logistics. Secondly, the logistics unit margin pulled down from 6% in the 1990's to below 4% (TNT, 2006).

TNT express services include time or day definite delivery, door to door collection and delivery, international customs clearance, full track and trace, proof of delivery and round the clock support. Four services form the core part of TNT's portfolio:

- 9:00 Express is an international time-guaranteed delivery service before 9:00 am the next business day.
- 12:00 express is a similar product than the first one but the delivery time limit is 12:00 am.
- Global express, is an international delivery service before the end of local business hour the next day.

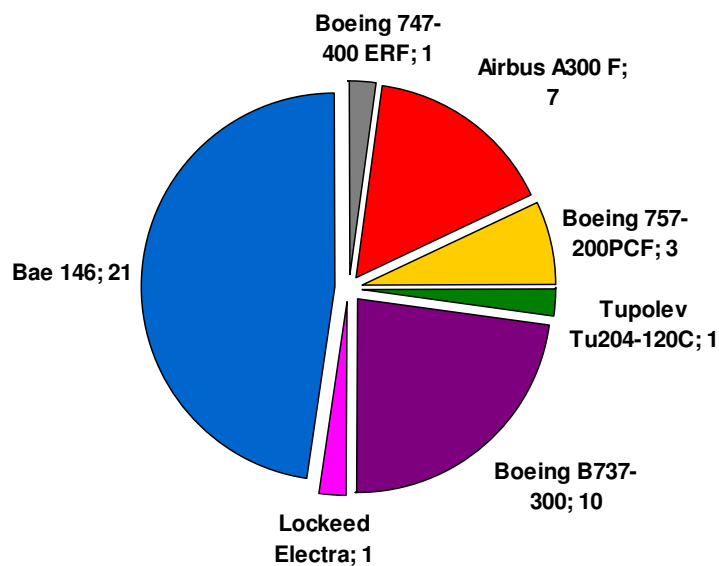
- Economy express is a day definite delivery service.

TNT Aircraft Fleet

TNT's aircraft fleet is the smallest of the four integrators, with 44 aircraft. TNT fleet is mainly composed of small freighter aircraft. For instance, 45% of the fleet is composed of BAe 146. TNT operates the greater fleet of the freighter BAe146. TNT's limited fleet is the result of a strategy focused on an intra-regional ground network connected using commercial flights capacity.

However, in the framework of its new strategy "Focus on Network", TNT has received its first Boeing 747-400 ERF (Air Cargo News, January 2007). The aircraft are used for expanding routes to China. Indeed the first aircraft will be used on the Shanghai – Liege trade line.

Figure 38: TNT fleet in 2006⁸⁵



⁸⁵ TNT , 2006

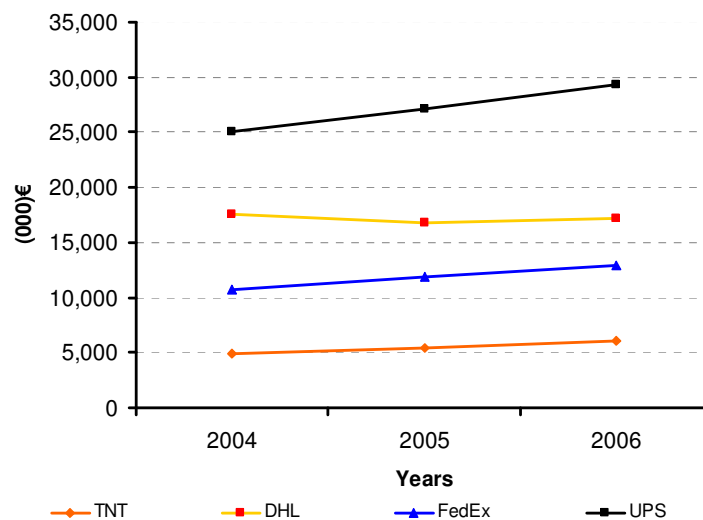
TNT Alliances

In the past two years the Dutch group acquired a series of specialised companies in order to consolidate the whole network, particularly in emerging countries. The purchases of TG+, Hoau In 2005; Speedage in 2006 and Mercurio in 2007 show a real strategic orientation towards emerging markets. TG+ acquisition is slightly different and enters in the strategy focus on strengthening the European network.

4.4.4 UPS Strategy

DHL strategy has been focused on aggressive expansion in the past, and recently, the carrier has decided to invest in its infrastructure in order to support the worldwide network. As shown in the figure below, UPS's position in the Express is strong. However, UPS data needs to be considered carefully as the different business segments are not separated in UPS contrary to its competitors.

Figure 39: Express Operating Revenue 2004-2006



UPS product portfolio

Six types of services are offered by the company in the European market as illustrated in the table below. The three cores products of integrators are present, 09:00 am next day, 12:00 next day and end of business day.

Table 2: FedEx service portfolio⁸⁶

Delivery Commitment		Service
Export and Import (Where Available)		
1-3 Business Days	Delivery typically by 8:30 or 9:00 a.m.	UPS Express Plus
1-3 Business Days	Delivery typically by 10:30 a.m. or 12:00 noon	UPS Express NA1
1-3 Business Days	Delivery typically by 10:30 a.m. or 12:00 noon	UPS Express
1-5 Business Days	Delivery by end of day	UPS Express Saver
2-5 Business Days	Delivery by end of day	UPS Expedited
Day Definite by date scheduled	Delivery during the day	UPS Standard

4.5 Conclusion

This chapter has given an overview of the four integrators' past, current and future strategies.

The chapter has first presented the company through an historical description. Then an analysis of market presence per geographic region has given the reader an understanding of the position and the role of Europe for the big four. Several points need to be taken into account for the following analysis. First of all, the express business remains the main or one the main activities of each integrator. Secondly, the express business is defined as capital intensive and requires heavy network structures. Consequently, integrators have invested massively, particularly in the developing market in the recent years. In Europe, DHL remains the market leader, UPS is the second largest operator resulting heavy investments. TNT is in third position and benefits synergy with the mail part of the group. Finally, FedEx is coming back to the intra-European market through local express company acquisition. FedEx is trying to drive more volumes in order to benefit economies of scale and improves the quality of its

⁸⁶ UPS, 2006

products' range. Thirdly, integrators have developed different transportation strategies. FedEx, biggest international scheduled freight carrier both in term of freight carried and freight-kilometres, is following a strategy based on integration. Indeed, FedEx owns the largest freighters fleet in the world in order to operate in-house air transportation in its home market but also internationally. FedEx also produces most of its revenue with its international products. At the other end of the scale, TNT, with a fleet of 44 aircrafts relies heavily in third party carriers and partnerships. Moreover, the Dutch integrators' strategy is more focus on domestic and intra-regional market than international and trans-continental connections.

This chapter revealed significant differences between integrators in term of market presence and transportation strategy. The author believes that this two components influence networks' configuration and hub selection. This statement will be analysed and discussed in the following chapters.

5 Research Methodology

5.1 Chapter overview

Having established objectives in chapter 1 and conducted an analysis of existing information and theoretical literature on the subject in chapters 2, 3 and 4, it is now possible to specify research propositions that will guide the collection and analysis of the empirical data.

This chapter, first, presents the analytical points and approaches to treat the objectives. Then a rapid review of the analytical methods considered will be given to the reader before a clear description of the research design including data collection and the selected analytical method.

5.2 Research Approach

In order to identify integrators' hub and spoke air network configurations in Europe, but also their strategies and the factors influencing those configurations, the analysis will be based on two points.

First of all, integrators' network designs will be compared and analysed taking into account theoretical rules from chapter 2 and strategies detailed in chapter 4.

The second point will be treated as follow. The potential change in DHL's network organisation will be determined, using map and strategy analysis. Then, the hub location both when serving own network and top European markets will be analysed. From the result, conclusions will either confirm or refute Doganis and Del Marmol's⁸⁷ statement presented in the next chapter.

⁸⁷ Interview with O. Del Marmol on Liege Airport situation in July 2007

5.3 Analytical methods considered

Based on Burghout researches (2006) three methodologies have been considered: the graph theoretical approach, the hub location–allocation model and the concentration measures.

5.3.1 The graph theoretical approach

The graph theoretical approach, mainly used between the 60's and the 80's, determines the spatial characteristics of networks. It defines “a network as a set of nodes and the latter as connection between the nodes”. According to Burghout, (2006), despite its large impact, this model “underestimates the dimension of a network”. The graph theoretical approach has contributed to the conceptualisation of airline networks, and the creation of different graph structures.

5.3.2 The hub location-allocation approach

The second model, the “hub location-allocation”, aims to optimize spatially the hub and spoke (Burghout, 2006). This model uses two different notions, the hub and the node. From this model, hub and spokes are seen as networks where a large number of direct connections are replaced with fewer indirect connections (O'Kelly and Miller, 1994). The hub location-allocation model has been used for hub network design problems. According to Burghout (2006) it is basically a problem involving a decision model. In the decision process to establish a hub network design, several questions are relevant (Burghout, 2006):

- Hub location?
- How to assign non-hub origin and non-hub destination traffics to the hub?
- How to link the hubs?
- How to route the traffic between origin and destination over the resulting network?

5.3.3 Concentration model

The third model according to Burghout is the concentration measure with the relation between the concentration of population and the hub location, developed by Reynolds-Feighan. However, the concentration measure has been applied to evaluate the concentration of traffic flow at the hub.

Applied by Wojahn (2001) to analyse the concentration of traffic flow and characterise the network structure, this model is excellent for the purpose of this analysis. This tool allows calculating several indexes to determine a hubbing index. In order to realise the calculation, traffic data are needed, such as the number of departing flights and capacity offered from the airport on departing flights. The application of this method to airline networks as hubbing indices is relatively easy. If the hubbing index is low, that means a significant share of traffic is served by direct flights, using point to point connections. The networks are then ranked from the most concentrated to the least concentrated as shown in the table below (Wojahn, 2001).

Table 3: Ranking of networks under hubbing indices⁸⁸

Networks	DHL	FedEx	TNT	UPS
Measures				
Concentration Ratio				
McShan-Windle index				
Herfindal index				
Theil index				
Coefficient of variation				
Gini index				

The concentration model is the ideal methodology for the specific requirements of this paper. However, it can not be applied due to a lack of relevant data. However, the first 2 methods have been used for the conception of the selected methods described in the following section.

⁸⁸ Wojahn, 2001

5.4 Analytical method selected

The analytical methodology applied during this study is a combination of three techniques. Consequently, this study does not apply every technique considered due to data limitations. Indeed, the concentration measure cannot be used to assess the role of the central hub in the network due to a lack of network data. This analysis has been carried out with the use of quantitative and qualitative data.

In order to identify and compare integrators network configuration, map comparison and hub location-allocation approach presented above have been used. These techniques are further developed below. The second point focused on central hub location and the case of DHL decision has been analysed applying an economic analysis and weighted distance calculations.

5.4.1 Map Comparison

Map comparison analysis is coupled with location-allocation approach. This analysis determines the network configuration selected by integrators. The process relies on theoretical models presented in chapter 2 coupled with explanation and data collected during interviews to support the results.

5.4.2 GDP & GDP growth comparison

In order to analyse the location of the central hub and particularly the choice of DHL, an economic comparison between the western and eastern European part have been done. The indicator selected in the process is the Gross Domestic Product.

GDP Growth comparison

The comparison has been done between the former fifteen European countries and eastern countries, selected in accordance with geographic and economic situation. The fifteen European countries selected are the ones part of the first stage of European Union. The Eastern European countries are Bulgaria, Czech

Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia, Croatia, Macedonia and Turkey.

The value used for the calculation is an indexed GDP value at market price based on 1995 value (100= 1995).

GDP comparison

The calculation compares, this time, countries located in or around the triangle defined by Del Marmol⁸⁹; Belgium, France, The Netherlands, United Kingdom, Germany, and Luxemburg with the same eastern countries selected above. The value selected is the GDP at current price in € million.

5.4.3 Weighted Distance calculation

Weighted distance calculation allows a more accurate assessment of central hub location, taking into consideration the distance and the economic interest of market served.

Weighted Distance to serve own network

The first calculation is related to the network served by the hub. The weighted distance calculation is based on several data. First of all, there is a need for destination served by integrators network. This information is available with the network maps. Secondly, distance between the hub and the spokes are required in the calculation. Thirdly, the GDP of each countries served by the network is part of the calculation. GDP value selected is again at current price in € million. The formula is following:

$$\frac{\sum (GDP * distance)}{\sum GDP}$$

⁸⁹ Interview with O. Del Marmol on Liege Airport situation in July 2007

Weighted Distance to serve top European destinations

The purpose of the second calculation is to reduce the impact of the network size in the assessment process. Indeed, in the case of FedEx and DHL networks, the distortion in the comparison is clear. FedEx's network is relatively reduced and focus on main European markets compared to DHL ones covering an extensive area in Europe including some remote areas. So, for this calculation hub location assessment is done on the same market basis, the top European markets. The selection process uses the 80/20 method. Selected countries account for 72% of the total European GDP ⁹⁰and 22% of the total number of countries⁹¹. Several destinations per country have been taken into consideration in order to cover different economic areas. Fifteen cities have been selected. The number of cities per country depends on the economic weight of the country. So, Germany producing the greater amount of value added in Europe, obtained the greater number of cities. The allocation process has been done as follows:

- 1: Germany= 4 cities (Berlin, Cologne, Frankfurt, Munich)
- 2: UK = 3 cities (London, EMA, Edinburgh)
- 3: France = 3 cities (Paris, Lyon, Nice)
- 4: Italy=2 (Roma, Bergamo (Milan))
- 5: Spain=2 (Madrid, Barcelona)
- 6: Netherlands=1 (Amsterdam)

Cities have been selected on integrators' interest basis, taking into account destinations served in the integrators' network.

5.5 Data Collection

The following section is concerned with a discussion of the primary and secondary data sources used during this study. The analytical methodology

⁹⁰ 27 countries

⁹¹ 6 countries selected out of 27

uses both quantitative and qualitative data in order to achieve a complete analysis.

Interviews

Research interview can be defined as “a two person conversation initiated by the interviewer for the specific purposes of obtaining research-relevant information” (Gardiner, 2006). The main advantage of interviews is the possibility to target and focus directly on the research topic but also to be flexible and adaptable to the person interviewed. It was planned to meet several persons from different parts of the industry. People targeted were specialist from each integrated carriers, airport used as hubs for integrators and academic specialists. It was crucial for this study to obtain opinions and information from each company concerned.

Two types of interviews have been realised, personal and phone interviews. Personal interviews have been performed in collaboration with the DHL Network and Security Manager for Hubs and Gateways in UK and Ireland and a specialist professor from Loughborough University. The purpose of the first interview was to understand the air network organisation within Europe and the strategy behind the choices made by DHL in recent years. The second interview was more targeted on qualitative and quantitative data collection.

A total of four phone interviews have been realised. The persons called were from DHL for two of them, Liege airport, TNT and FedEx. The purpose of phone interviews was similar to personal ones, obtaining quantitative & qualitative data plus explanation on the strategy and network organisation.

The main gap in the interview process was the non presence of UPS contact, leading to a lack of clear explanations and details. The data obtained from this collection process were mainly qualitative. Some quantitative data was acquired

with collaboration of relevant persons, particularly from subcontractors⁹² and airport authorities⁹³.

Secondary data

In addition to interviews, secondary data was used, mainly from annual reports, investors' face book, European statistics databases, and integrators' annual reports.

5.6 Chapter Conclusion

This chapter has addressed and briefly presented the selection and execution of three methods to address the research objectives. These map, GDP and weighted distance comparisons will provide foundations to establish results and conclusion on the integrators' network strategies in the intra-European market.

The chapter has first determined the research approach based on two points. Then several methods considered have been presented before the selected ones. Finally a brief description of the data collection process is provided to the reader.

⁹² Air contractors

⁹³ Copenhagen airport

6 Integrators' Networks

6.1 Chapter Overview

The aim of chapter 6 is to present and comment on the results obtained from the analysis in order to realise the objectives of this project. The discussion is organised in three parts. The first part is focused on the central hub location analysis, in order to determine the key factors influencing integrators' decisions. The case of the hub selection is presented first on a worldwide scale before focusing on the European market. The second part will present the results of the map analysis to determine the network configuration. Integrators' Hub and Spoke network configurations are first revealed and analysed before describing the international connection with these networks and those design strategies. Finally, the final part will show the temporal organisation of integrators' networks.

6.2 Hub Location

One of the most important values in network architecture is the key role played by central air hubs, particularly with the use of combined air and ground transport (DPWN, 2006). The first section refers to continental hubs location selected by integrators, and then the second section examines the European situation.

6.2.1 Continental hub

Continental hubs play a major role for integrators' worldwide network. Three out of the four main express operators have chosen investing in three places to support their global network: Europe, US and Asia. Regarding the following maps, similarities are visible between central hubs locations. DHL has opted for

three geographic places, Brussels ⁹⁴ in Europe, Hong Kong ⁹⁵ in Asia and Wilmington ⁹⁶ in the US as shown in the figure below.

Figure 40: Map of the former DHL intercontinental network⁹⁷



FedEx also operates three central hubs in Memphis⁹⁸, Paris⁹⁹ and Subic Bay¹⁰⁰ as can be seen in the figure below.

⁹⁴ In Belgium

⁹⁵ In China

⁹⁶ In Ohio, USA

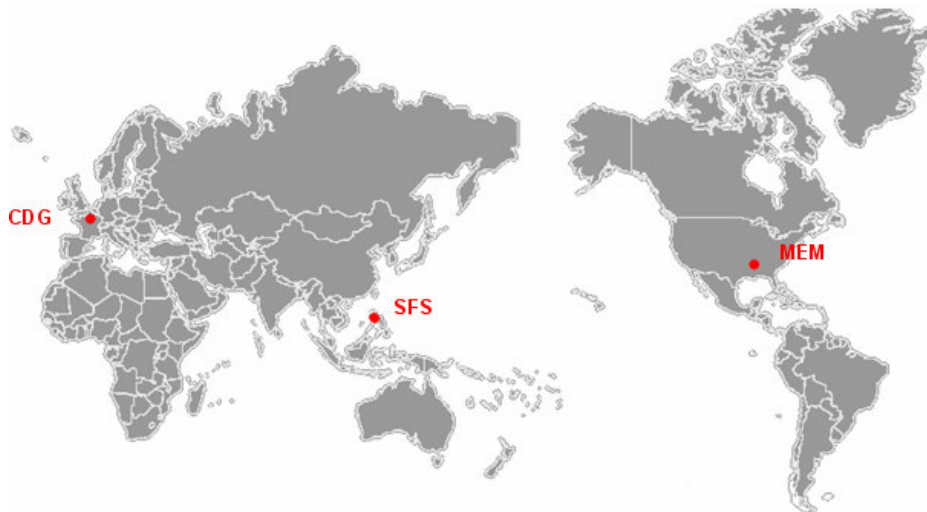
⁹⁷ ILM-HKG: 13620 km; BRU-ILM: 6643.5 km; HKG-BRU:9381.4 km

⁹⁸ For US

⁹⁹ For Europe

¹⁰⁰ For Asia

Figure 41: Map of FedEx intercontinental network¹⁰¹



The three regional hubs used by UPS are Louisville (USA), in America, Cologne-Bonn in Europe and Taipei (Taiwan) for Asia, illustrated in the figure below.

Figure 42: Map of UPS intercontinental network¹⁰²



In the case of TNT, the Dutch group has officially only one continental air hub in the world at Liege. This situation is the result of a strategy based on domestic

¹⁰¹ SFS-CDG: 10709 km; CDG-MEM: 7335.5 km; SFS-MEM: 13601 km

¹⁰² TSA-CGN: 9435.8 km; TSA-SDF: 12449 km; CGN-SDF: 7019 km

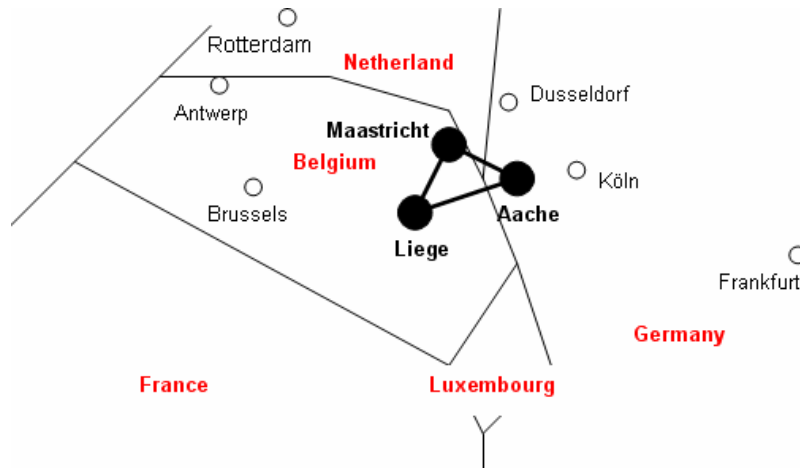
and intra-regional road networks connected with commercial flights capacity. Under these circumstances TNT needs less in-house airport infrastructures. Regarding the case of Shanghai, Van Der Berg¹⁰³ (2007) certifies that the Chinese airport is not perceived as a hub despite direct connection to Liege. Hong Kong and Singapore also do not carry out the function of central hub, despite concentrating most of the shipments directed to Asian markets carried in block space of commercial flights.

This description has underlined similarities in continental hubs' locations. Indeed, in North America, three central hubs are basically located in the eastern part of the US. In Asia and Europe, the situation is comparable. In the first continent, the likely place chosen to operate a major hub seems to be the South West Asiatic area, such as locations like Hong Kong, Subic Bay and Taipei. Similarities in continental hubs locations show the presence of strong common factors influencing integrators in their geographic selections. This point is further developed through the case of Europe in the next section.

6.2.2 The European Continental Hubs

Regarding the past decision made by integrators to set up a continental hub, a particular area seems suitable. This specific zone, illustrated in figure 43 has been defined by Doganis and associates (1999): "On all these grounds, the ideal location for an express continental hub lies in the Aachen-Maastricht-Liege region on the borders of Belgium, Luxembourg, the Netherlands and Germany".

¹⁰³ Interview with E. Van Der Berg on TNT route network in August 2007

Figure 43: Ideal location for a European continental Hub¹⁰⁴

This statement is confirmed by Del Marmol¹⁰⁵ who believes that the main advantage of Liege airport is its geographic position. Del Marmol gives a first factor by announcing that 65% of European industry is located within the geographic triangle between Amsterdam, Frankfurt and Paris, displayed in figure 31.

Figure 44: TNT main hub location¹⁰⁶

¹⁰⁴ Doganis & Associates (1999)

¹⁰⁵ Interview with O. Del Marmol on Liege Airport situation in July 2007

¹⁰⁶ http://www.tnt.com/country/en_ta/about/company/airlinesmainbase.html

Moreover, three of the four integrators have located their main European hub in this region i.e. UPS at Cologne¹⁰⁷ Airport, TNT at Liege Airport, DHL¹⁰⁸ at Brussels. This trend reinforces the idea that hub location is influenced by proximity of the market and industrial density. This factor corresponds to a commercial sense where suppliers look for geographical proximity with their potential customers. However the fourth operator, FedEx, has selected Paris Charles De Gaulle airport for its central European hub. This choice is due to several factors, such as a different operating strategy and the chance to access the large Parisian market. Vogels¹⁰⁹ explains that Paris is an excellent position regarding the main European markets, France, Germany, United Kingdom, but also Italy and Spain. Paris is at the middle of these markets. However, compared to the competitor hubs, Paris location is less appropriate to connect eastern and central Europe markets. Based on the previous discussions the first and main factors influencing hub selection seems to be the proximity to the market and industrial concentration where the airport is located. However, the author believes other factors could influence the selection. The case of DHL central hub move from Brussels to Leipzig provides further explanations.

The DHL decision to transfer the European Hub location

DHL decided, in 2004, and is processing to change the location of its European super air hub from Brussels airport in Belgium to Leipzig Halle airport in Germany. One of the main reactions following this decision was a surprise as the German airport does not benefit from an international reputation. "Leipzig Halle airport was not well known in the industry until after the DHL move..." (Air Cargo News, 02/2007).

However, a change of hub is excessively costly and must be justified by different reasons. Indeed, the airport contains a series of serious advantages compared to the previous hub. The airport operates 24 hours thanks to a

¹⁰⁷ Köln in German

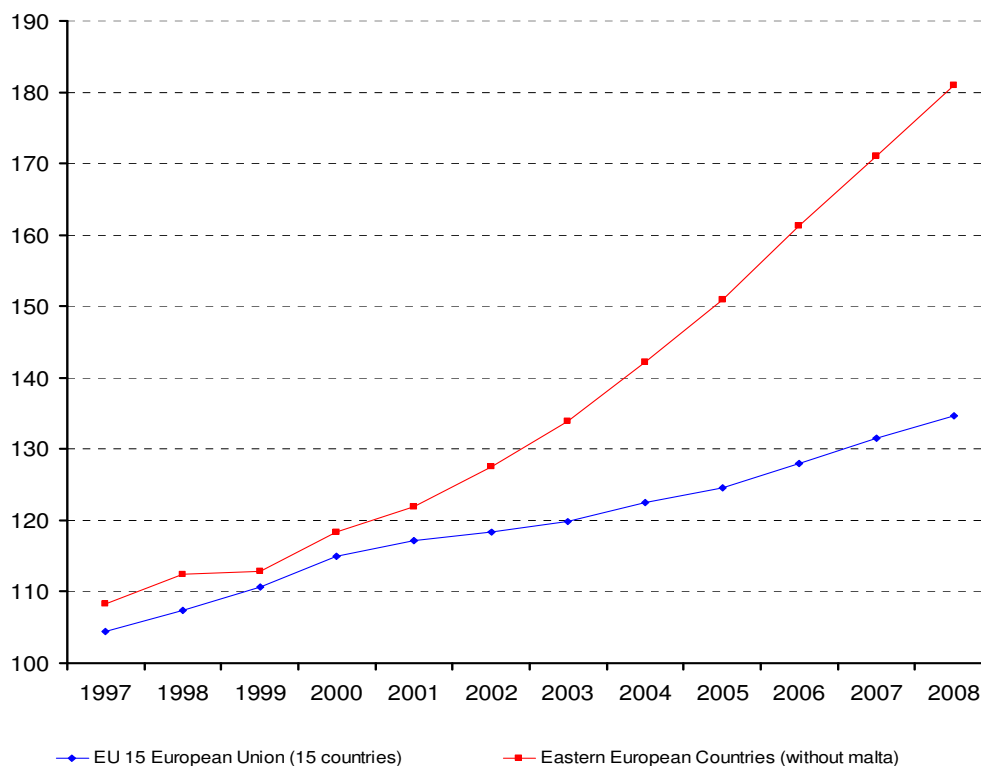
¹⁰⁸ A DHL sub-hub is located at Cologne Bonn airport

¹⁰⁹ Interview of A. Vogels on FedEx air route network in August 2007

location far from the city centre. The airport, not well known, provides possibilities of extension with unexploited land surfaces and infrastructures already established. The cost of air operation in the new airport is cheaper than traditional hubs. Finally the airport enjoys a more central location within Europe than traditional hubs, closer to the growing eastern European market and allowing the development of its road network, cheaper than air links. The following argument is subject to discussions within the express industry. Despite the fact that Eastern Europe is now more dynamic ¹¹⁰than the western part, as illustrated by figure 32 comparing GDP growth between the former fifteen European countries and eastern countries, the market size remains largely different.

¹¹⁰ In 2006, eastern countries GDP growth was 2.4 times greater than the former 15 European countries performance

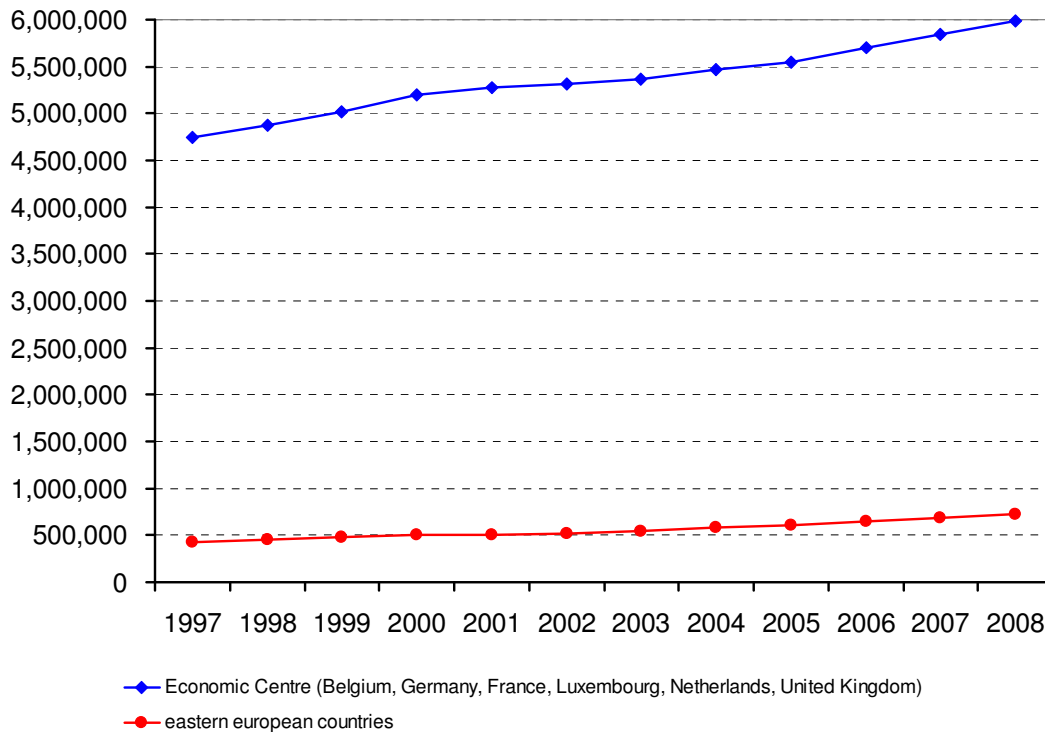
Figure 45: Comparison GDP variation between 1997 and 2008 for Western and Eastern Europe ¹¹¹(index 100 = 1995)



Considering the statement made by Doganis & Associates regarding the position of competitors' continental air hubs, a comparison of GDP, at current price, has been done on the period 1997-2008 (see figure 33). The value for 2007 and 2008 are forecasted and data have been extracted from Eurostat. The comparison deals with the countries located around the triangle area Maastricht-Aachen-Liege and Eastern European countries. Despite a slight reduction, disparities between the two groups are momentous. The first group produced a consolidated GDP more than eight times greater than Eastern countries.

¹¹¹ Eastern Countries: Bulgaria, Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia, Croatia, Macedonia, Turkey. Due to lack of data, Malta is not included in the calculation and for years 1997 and 1998, Romania is not included in the calculation for the same reason. Eurostat data(<http://epp.eurostat.ec.europa.eu>)

Figure 46: Comparison of GDP produced between 1997 and 2008¹¹² in Millions of Euro (at 1995 prices and exchange rates)



In order to go further in the analysis, a weighted distance calculation has been done for each integrator's central hubs, taking into account DHL's decision problem. So, an average distance weighted by GDP has been realised in order to consider two sensitive values in central hub location; distance and market dynamism. The first figure assesses the central hub location in comparison to its home network. Looking at figure 8, the reader can remark an excellent position of Paris for FedEx network and a decrease in DHL central location performance. It means that the average distance between Leipzig and DHL's core markets is greater than with the previous central hub location. Moreover, Doganis and Del Marmol¹¹³ statements seem to be confirmed as Liege¹¹⁴ and

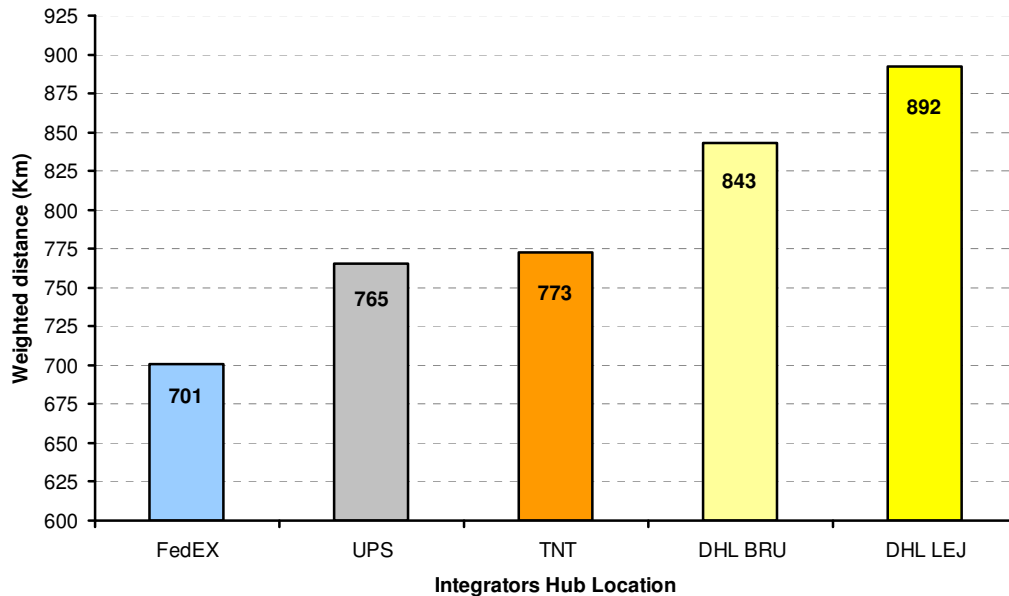
¹¹² Malta and Romania GDP are not included for the respective: 1997-2000; 1997-1998. Source: Eurostat 2007

¹¹³ Interview with O. Del Marmol on Liege Airport situation in July 2007

¹¹⁴ TNT

Cologne¹¹⁵ are relatively close to their markets with an average weighted distance approaching 780 km (figure 34). The case of FedEx’s location needs to be taken carefully regarding FedEx’s network which is mainly focused on the European economic centre called the “blue banana” including industrial areas from the Netherlands to northern parts of Italy.

Figure 47: Weighted Distance to serve their own network



In order to compare hubs’ location on the same basis, the second figure presents the results of a weighted distance calculation for locations serving the top European markets. The second figure confirms the statement deduced with the first calculation presented above. First of all, Del Marmol’s and Doganis’ statements are confirmed. Liege¹¹⁶ and Cologne¹¹⁷ are the best locations considering only the latter analysis. Indeed, both cities have an average weighted distance around 570 km. Secondly, the second calculation confirms the impact of the network size on the first calculation (figure 35). Finally, the disadvantage of the new DHL location is confirmed. The Leipzig average

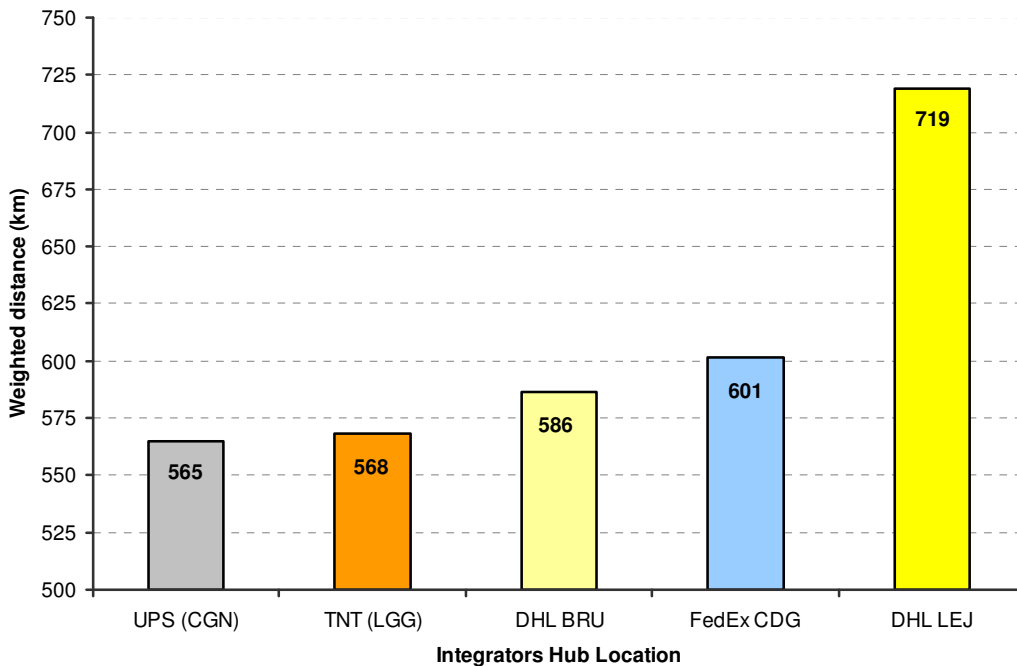
¹¹⁵ Cologne

¹¹⁶ TNT

¹¹⁷ Cologne

weighted distance increased by more than 22% compared to Brussels. However, the results have to be taken with caution regarding the future prospect of the European economy. Indeed, a significant development is planned to happen in the eastern European area. Industry in this area is developing rapidly and will create further opportunities for the express industry.

Figure 48: Weighted Distance to serve the top European destinations



Regardless of this concern, DHL's decision will have a massive impact for the new airport. Leipzig airport will be the third freighter airport in Germany and the third biggest DHL hub following Hong Kong and Wilmington in USA. However, the new network organisation required to integrate the future central hub is another concern for DHL but several explanations have been communicated by DHL's manager at Leipzig airport to clarify the situation. According to the manager, Brussels operations are going to continue as a sub-hub and Cologne ones as a gateway (Air Cargo News 02/2007). The chronology of the move is following. In February 2007, DHL located 12 aircraft and Lufthansa had moved 6 MD-11 from the Cologne-Bonn hub due to joint venture agreements. The German carrier agreed to swift operation for DHL from Cologne-Bonn airport to

Leipzig in order to maintain this collaboration: “Lufthansa cargo is getting 20% of its revenue from DHL and wants to expand relationship and to participate in their growth” (Air Cargo News 02/2007). In October 2007, DHL will locate 17 aircraft and in April 2008, DHL’s operation will account for 33 aircraft. In 2006, 30,000 tons were handled by the airport, 100,000 will be handled in 2007 and the quantity planned to be handled in 2008 is around 450,000 tons such 80% provided by DHL (Air Cargo News 02/2007). In 2008, intercontinental connections will be added and in the future the airport will have a cargo railway station. The new hub will allow improving service quality and capacity to some eastern emerging countries but would not create a massive opening of new routes. The network is flexible and adaptable to a new demand on particular routes. There will be some changes such as the Cologne connections or regarding domestic air routes in Germany which will be switch to truck links (Interview with J. Becasse on DHL’s route network, 3rd July 2007).

Manley¹¹⁸ asserts that at DHL, the decision process to select a hub, a sub-hub or a gateway relies on a combination of several factors such as capacity, environmental concerns, possibility of consolidation, location, geography, weather conditions, and capacity to create inbound and outbound traffic. Manley takes the example of Metz to illustrate this statement. Metz is a former DHL hub during a short period, its location was excellent, the capacity suitable for express operations but difficulties to consolidate enough freight compromises DHL’s interest to operate this place. The case of Vatry is similar to Metz, according to Manley. The airport, in competition with Leipzig to host the new DHL European air hub, provides an excellent capacity¹¹⁹ with two runways, effective surface transport connectivity but its downside is the inability to drive sufficient local traffic. The opposite example concerns Paris as stated by Manley. Paris Charles De Gaulle airport has an excellent location to drive origin traffic. However, operating in such airports brings several issues to deal with, such as slot restriction and night curfew eg in Frankfurt or Heathrow. One the

¹¹⁸ Interview with A. Manley about DHL air route network in July 2007

¹¹⁹ It is uncommon in Europe to see a pure two runways freight airport

examples selected by Manley¹²⁰ was the situation occurring in London Heathrow where an aircraft landing and taxiing after 10h30 must park for the night.

The case study about DHL central hub move has provided further discussions and factors to consider while selecting a hub in Europe. First of all, the main factor influencing integrators' decision is the proximity to the market served and industrial concentration. The weighted distance analysis provides the proof of Liege and Cologne airports attractiveness through their proximity to integrators' markets. The case of FedEx, based in Paris, shows the same desire for the American integrator to be closer to its core market located in the "blue banana". Moreover several others factors has been announced by DHL. Indeed, the capacity of the runway, through slots restriction, night curfew and airport charges are extremely sensitive factors as timing and cost efficiency are key factors of competitiveness in this market. The possibility of a future night ban and environmental concerns of the local community at Brussels airport has been seriously considered in DHL expansion plan. Another factor is the possibility to expand and built necessary facilities for logistics and consolidation purposes. The capacity is driving traffic is also key factor provided by the author to explain hub selection in Europe. The cases of Metz or Vatry prove that providing an excellent location and sufficient capacity is not enough to attract integrators. Indeed, the possibility of driving local inbound and outbound traffic is also a major concern for integrators. The latter factor reinforces the reasons why FedEx selected CDG airport, despite slot restrictions and high operational cost. Finally, network strategies selected by integrators needs to be considered while analysing hub selection. The last factor, influence of the network structure, will be discussed through integrators network description and analysis in the following sections.

¹²⁰ Interview with A. Manley about DHL air route network in July 2007

6.3 Intra-European Networks geographic structures

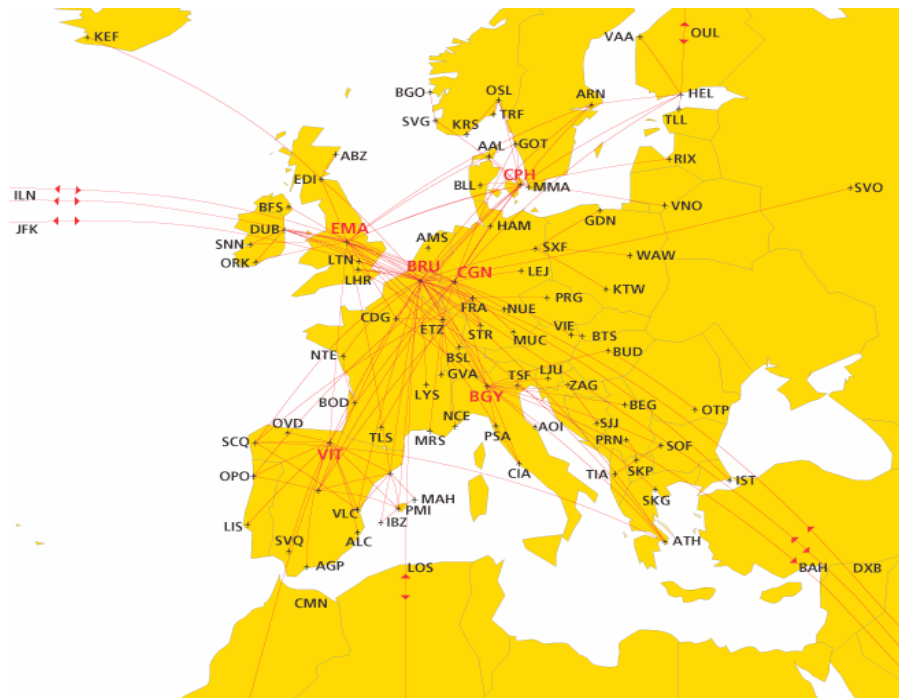
The four integrators operate different network structures using different airports. This part will describe the structures applied by the four integrators and their strategy behind it. This part will first present the four networks, then describe the connections with the international networks and finally present the different features of the decision process.

6.3.1 Network Configuration and Operations

DHL is used to operate a dense air network within the European market, through three nodes levels, the Hub previously based in Brussels, the five sub-hubs in East Midland, Copenhagen, Vitoria, Bergamo, Cologne-Bonn airports and several gateways, as presented in the figure below. In order to illustrate the density of DHL air network in Europe, the case of France is taken into consideration. The French market is now ¹²¹served by eight air centres¹²² (Interview with J. Becasse on DHL's route network, 3rd July 2007).

¹²¹ 16,080 tonnes of fret were handled In 2003 at Metz airport but in 2006 DHL ceased its operation at the French airport.

¹²² Nantes, Bordeaux, Toulouse, Marseille, Lyon, Mulhouse and Paris Charles De Gaulle

Figure 49: DHL European Air Network in 2004¹²³

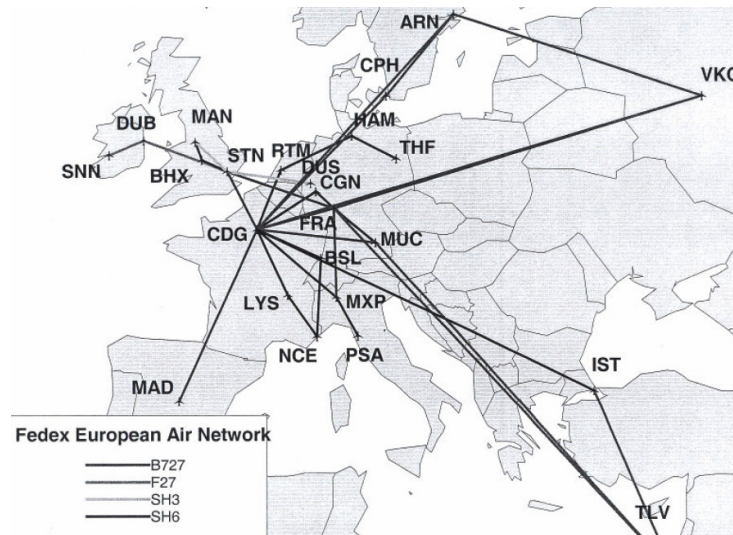
In the case of FedEx, describe by Vogels¹²⁴, the main European hub is located in Paris, as show in the figure below. In figure 36, the FedEx network configuration displays the characteristics of a single hub and spoke structure with several cases of by-pass traffic. Indeed, in term of quantity, the Paris hub absorbs 95% of intra European connections and 60% to 70% of international connection with Europe. Quantity of freight going through Paris every day reaches 70,000-80,000 packages. The network is also composed of intermediary nodes in Cologne, Malpenza and Madrid. Vogels relates the case of Malpenza. Paris is connected with Malpenza twice daily using A300 and then from the Italian airport, feeder flights are operated to final destination. Moreover, Cologne is a possibility to create a future sub-hub, due to its strategic central position in order to support a future eastern expansion if the demand increases in this market.

¹²³ Gillingwater, 2007; BRU-VIT: 1046 km, BRU-CPH: 755 km; BRU-EMA: 456 km; BRU-BGY: 697km; BRU-CGN: 186 km

¹²⁴ Interview of A. Vogels on FedEx air route network in August 2007

The figure below presents another characteristic of the FedEx network. Indeed, the structure is less dense than its competitors, and this can be explained by a lower presence of the North American group in the intra-European market compared to its rivals. This case demonstrates a relationship between the market presence and commercial orientation with network configuration.

Figure 50: FedEx European Air Network in 2004¹²⁵



TNT on another hand operates a dense network as indicated in figure 51. According to Van Der Berg¹²⁶ (2007), one of the strengths of TNT resides in having the least expensive network in Europe compared to others integrators. The figure below confirms that TNT operates a hub and spoke air network where Liege airport is essential. Van der Berg confirms the role of the Belgium airport:

“Anything that goes in Europe goes by Liege”

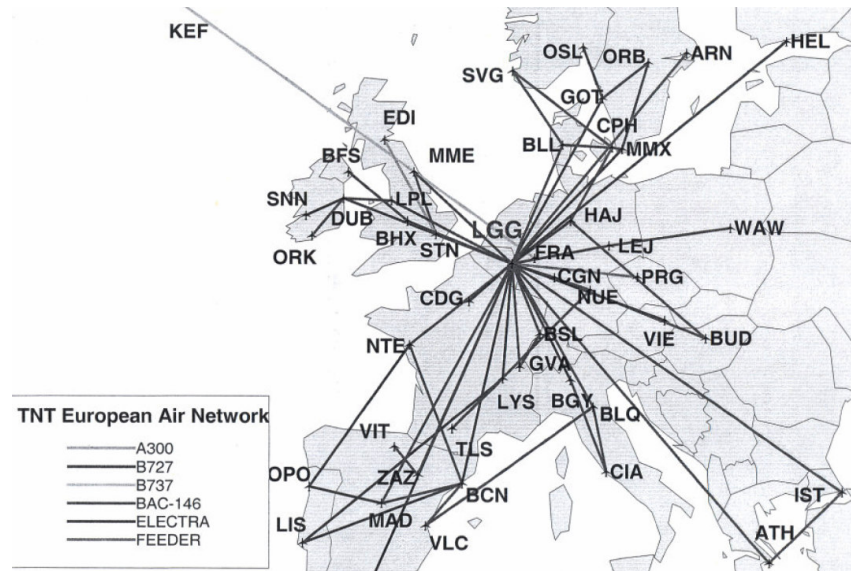
In fact, despite few direct air links done domestically, or within an area i.e. between Spain and Italy, in Scandinavia or within the British Isles, Van Der Berg (2007) estimates that 90 to 98% of intra European traffic and 70% of all TNT

¹²⁵ Gillingwater, 2007

¹²⁶ Interview with E. Van Der Berg on TNT route network in August 2007

Express international overnight express consignments go through the hub. Liege is connected daily to 69 European cities¹²⁷ and around 12 intercontinental destinations (TNT, 2007).¹²⁸ Moreover, in figure 51 appears that TNT uses several intermediaries and stop-overs to concentrate operations such as in Madrid, Copenhagen, and Bergamo.

Figure 51: TNT European Air Network in 2004



The high concentration of TNT air network at LGG airport can be explained by 2 characteristics of TNT strategy. First of all, TNT Express relies heavily in road transport within the European market. Consequently, the air network does not absorb the same volume as its European main competitor, DHL. Secondly, one of the strategic target of TNT is economy of scale. Indeed, TNT tries to “push volume through its network” (ABN AMRO, 2006), which could explain the concentration of its air network through its hub.

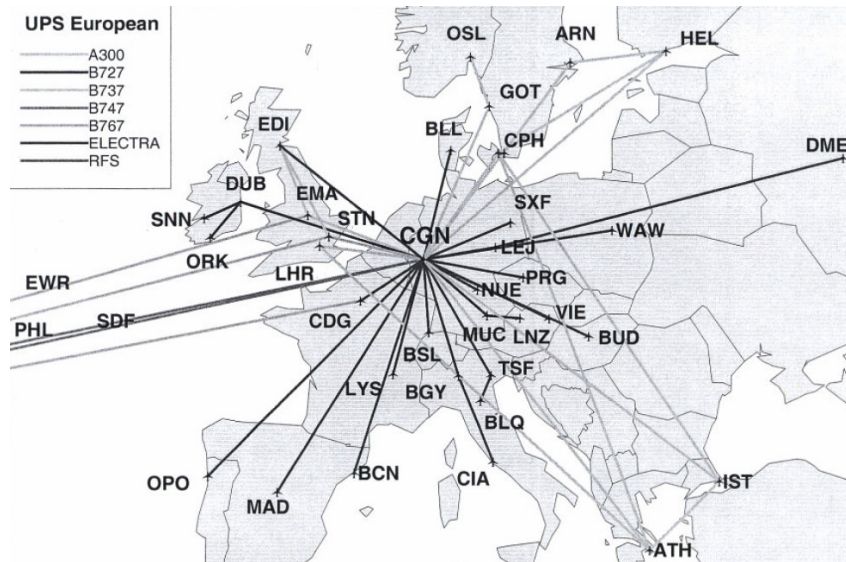
Regarding now the case of UPS, described in figure 52, the reader can remark a clear single hub network configuration. Indeed, UPS concentrates air routes at its Cologne Bonn hub, despite the use of intermediaries such as Copenhagen

¹²⁷ February 2006

¹²⁸ http://www.tnt.com/country/en_ta/about/company/airlinesmainbase.html

airport as shown in the map below. From its main hub, the European network serves 69 intra-European and 10 intercontinental destinations (UPS, 2007).

Figure 52: UPS European Air Network in 2004¹²⁹



The comparison between UPS and FedEx European's networks can raise an interesting observation. Indeed, UPS which benefits a better presence in the European market, as discussed in the previous chapter, operates a denser network. This comparison demonstrates a relation between the size of integrator's business and the density of its network.

Compared to its competitor, the DHL geographic organisation is different. Draycott¹³⁰ affirms DHL network configuration does not respect a pure single hub and spoke design due to numerous disparities such as the presence of sub-hubs or direct to direct routes between sub-hubs. The features of this network are closely similar to the one of a multi hub network. Indeed, regular connections are made between the hub and sub-hubs and both structures are part of the shipment journey, for instance Becasse¹³¹ uses the case of a

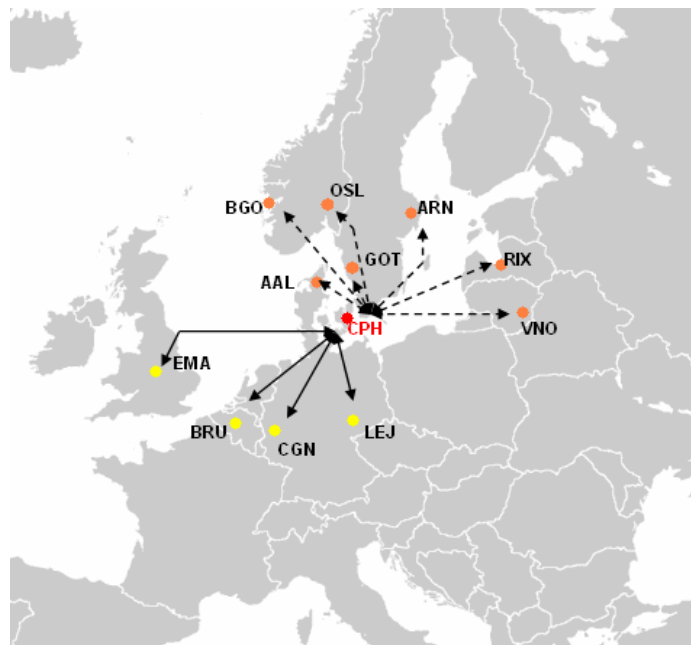
¹²⁹ Gillingwater, 2007

¹³⁰ Interview with A. Draycott on DHL air route network in August 2007

¹³¹ Interview with J. Becasse on DHL's route network, 3rd July 2007

shipment coming from Wilmington to be delivered in Rome. The shipment will pass through the Brussels hub and Bergamo sub-hub before being routed to Rome Ciampino. Furthermore, in several cases sub hubs are by-passed or numerous air centres are not directly connected with the hub or sub-hub (Interview with J. Becasse on DHL's route network, 3rd July 2007) i.e. the case of Bordeaux, connected to Brussels through Nantes:" There are regular connection between Brussels and Nantes and then between Nantes and Bordeaux with Boeing 757". Considering these arguments and figure 49, it can be concluded that DHL operates a multi hub configuration network, with Brussels remaining the main node. In order to illustrate this statement, a deeper look has been done on DHL scheduled of a sub-hub, Copenhagen airport, obtained thanks to Mr. Lars Korup. The DHL temporal organisation at the airport, presented later in this paper, allows dividing destinations in two groups, the spokes (orange) and the hubs (in yellow). The figure shows the characteristics of a regional hub connecting a local area with the rest of the network. The yellow nodes confirm the presence of several hubs.

Figure 53: DHL destination to/from CPH airport



Indeed, this figure shows the typical network organisation of the DHL network in Europe. Each sub-hub serves a local area and is connected to the different hub

or sub-hub of the continent. The models of Copenhagen schedule are similar to the features of a regional hub, presented in chapter 1.

The use of multi hub configurations can be understood by the fact that DHL is the market leader in Europe and reaches a sufficient level of traffic to support this structure. Comparing DHL's European network with DHL's North American network shows a tremendous difference. In US, the German company operates a single hub network. Moreover, the multi-hub configuration provides also an explanation of new DHL central hub location at Leipzig airport. Indeed, the presence of several intermediary hubs sufficiently close to their local markets provides more flexibility at DHL to select its new location. The location of the hub is less sensitive to the proximity of the demand.

6.3.2 International connection with the European Network

Contrary to its competitors, Heathrow is part of DHL's intra-European network. However, the British gateway only plays a role in the worldwide network. Indeed, the British airport is used for its tremendous belly hold capacity on intercontinental flights. Regarding the fact that DHL does not operate its own fleet for intercontinental flights, DHL operations at Heathrow airport are comprehensible. In complement to the airport, East Midland and Cologne Bonn are used to serve as intercontinental gateways, respectively for North American and Asiatic links. Cologne Bonn performs this function since the agreement between Lufthansa and DHL to share capacity on Lufthansa freighter flights to Asia. FedEx also uses this type of node in its network. London Stansted (main), Frankfurt, Manchester¹³² and Cologne are FedEx gateways for international connexion to North America (Vogels¹³³, 2007). Moreover, FedEx is more flexible for its intercontinental network than for its intra-European one. Indeed, possibilities to have direct connections between the markets are high. This

¹³² Manchester FedEx air centres will start during spring 2008

¹³³ Interview of A. Vogels on FedEx air route network in August 2007

statement means that intercontinental flights do not necessary connect continental hubs.

Looking at TNT, the Dutch company uses Frankfurt, Amsterdam, Paris, and London airports to perform international connections from and to Europe (Van der berg¹³⁴, 2007). The use of major European airports to expedite shipments is attributable to the fact that, similarly to DHL, TNT relies on commercial belly hold capacity for intercontinental flights. In complement to these connexions, the Dutch company set up early this year a new route, served four times weekly from Liege to Shanghai using its recently acquired 747-400ER fleet,. This airlink is the result of a strategic decision to connect the future two larger TNT markets.

6.3.3 Network development strategy

Manley¹³⁵ asserts, when designing the intra-European air network, that DHL follows traffic demand. For instance, the examination of new routes from Bratislava demonstrates that in the case there is not enough traffic the aircraft is routed to another city to fill it. It is a matter of trade and balance. In the case of unbalanced traffic, DHL tries to split the aircraft uses with another operator like it has been the case with TNT in the past. In the case of an increase in demand, DHL considers the option of upgrading the aircraft size, but this solution is very expensive so the intermediary step can be the share of capacity. Manley¹³⁶ summarised DHL's strategic approach when considering a new service:

“If it induces minor change, and implies good product opportunity, we do it”.

At DHL, the decision process to expand some part of the network or reduce others one depends on two main features. First, sufficient demand needs to be established. In some case, a route can be operated for only one customer. Manley take the example of Finland. In the past, there were route dedicated to

¹³⁴ Interview with E. Van Der Berg on TNT route network in August 2007

¹³⁵ Interview with A. Manley about DHL air route network in July 2007

serve Nokia factories. Secondly, the decision can result in a particular situation in a country. In the case of a poor road network affecting the quality of service in an area, i.e. the case in Ukraine or Slovakia, DHL uses small aircraft to connect the spokes. It is a trade off between quality of product and operating cost (Interview with A. Manley in July 2007).

At FedEx, the decision process to expand the network is done centrally. Vogels¹³⁷ explains that every time a business case is done. FedEx concerns are local operations, marketing, strategic, and competitive position. When the decision is taken, FedEx first operates subcontracted operators in the case of a poor presence in the area. Then, in order to improve products and if it is economically viable, proper FedEx planes are operated.

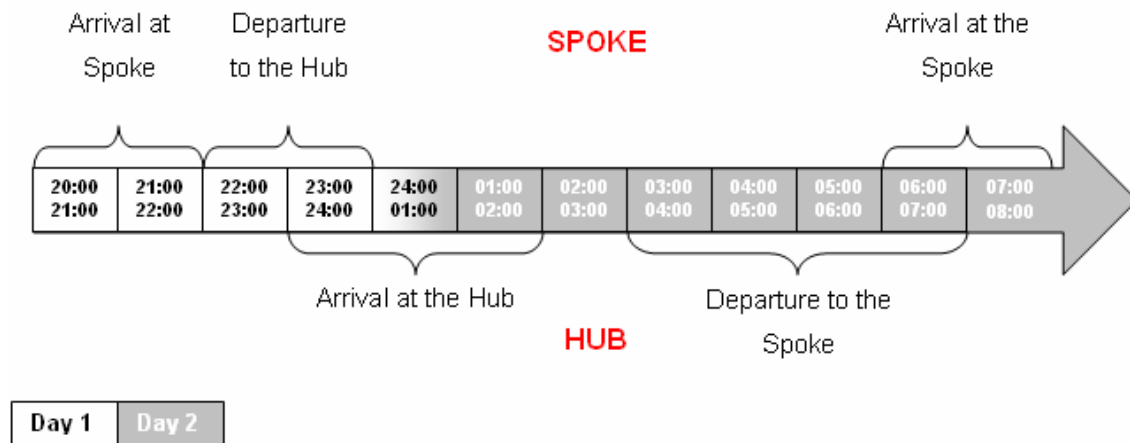
6.4 Intra-European Air Networks temporal organisation

Following the four integrators' spatial organisation analysis, temporal organisations are now considered in order to understand some operating differences.

The figure below presents DHL's temporal organisation for its air intra-European hub. First of all, shipments are routed to the local air centre (spoke) until 22:00. Following consolidation stage, shipments depart to the hub or sub-hub between 22:00 and 24:00 local time to arrive at destination between 23:00 and 02:00 (next day) local time. Arrived at the hub, shipments are consolidate in the sorting centre. Next to the consolidation stage, shipments leave to the spokes in order to reach air centres between 06:00 and 08:00.

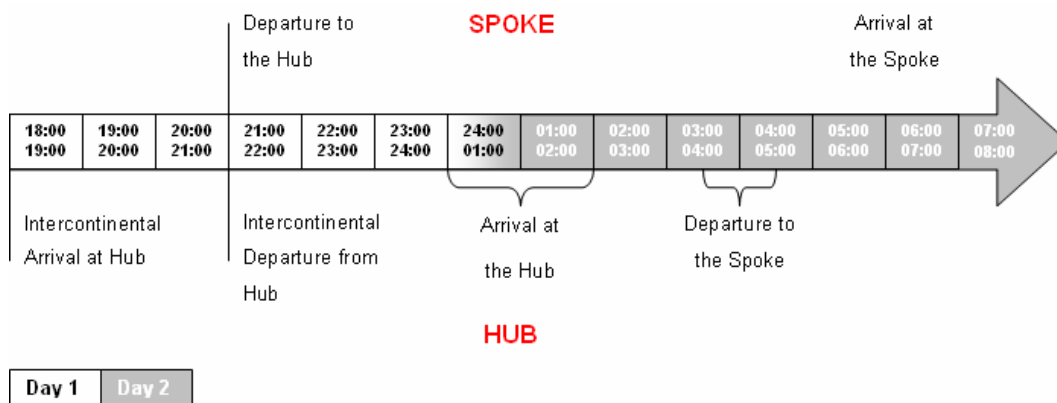
¹³⁷ Interview of A. Vogels on FedEx air route network in August 2007

Figure 54: DHL temporal organisation for intra-European network¹³⁸



FedEx has a different operating pattern, with the main sort at the Paris hub occurring between 1800 and 1930 rather than between 0200 and 0300 as described in the figure below.

Figure 55: FedEx temporal organisation for intra-European network¹³⁹



¹³⁸ Becasse and Du Chazaud interviews (2007) (in local time)

¹³⁹ Vogels and FedEx annual report (2007), (local time)

The main reason for that difference is the result of a strategy more focused on Europe's international market than intra-European one. Consequently, the carrier takes advantage of the differing time zones to optimise transatlantic deliveries as shipments from Europe arrive at Memphis just after midnight local time and are distributed throughout the USA by 0900 am (Doganis and Associates, 1999). One of the disadvantages of this system is collection time earlier than its competitor on another hand the delivery is performed earlier than rivals as explained by Doganis & Associates (1999).” FedEx had to compromise on the latest time that goods can be collected from the reception or the factory gate if they are to fly via the Paris hub to European destinations”. Moreover, DHL founds another option. Indeed, when the whole journey could be completed by truck, which is the case for much of North West Europe, the company could perform later collections (Doganis and Associates, 1999). In order to complete the road network, FedEx also operates early morning slots but is restricted at Paris Airport.

6.5 Conclusion

Chapter 4 allows drawing several statements analysed during the analytical process. Knowing that integrators follows different strategy market and operates at different levels of presence in the European market, the autor supposes that integrators strategy and business size the European market influence their network configuration and so their hub location.

In order to develop this supposition this chapter discusses the outcome of the author analysis, organised in three points: the central hub location, the Intra-European Networks geographic structures and their temporal organisation.

Three out of four integrators operate 3 continental hubs to support a worldwide network. The exception, TNT, has decided to develop intra-regional ground network completed with air links and to connect directly these networks using commercial flights. Consequently, TNT does not need continental hubs out of Europe, where the intra-regional air network is dense. Another point from this analysis is that integrators tend to select similar strategic areas, close to market

to position their continental hubs. In the case of Europe, the strategic area is located between Paris, Frankfurt, and Amsterdam. However, the recent DHL move to Leipzig does not follow this rule. The first conclusion that can be drawn from the first part is the influence of several common factors while selecting a continental hub. The main driver is the proximity of the demand. Indeed, the reason of the attractiveness of such geographic area, described above, is the proximity to the main European business centres. The weighted distance calculation demonstrates that the two best hub locations selected by integrators are Cologne and Liege. Moreover interviews with professional reveals other significant factors in the selection process i.e. airport capacity, possibility of night operations, operational cost and the airport capability to drive traffic. In addition, the author conclude through the case of DHL that network configuration can influence the degree sensitivity to market proximity in the decision process.

The four integrators have adopted different network configurations and different strategies. However, two network configurations emerge. The first one, the single hub and spoke configuration with stop-over and intermediaries' nodes, is adopted by FedEx, TNT and UPS. The second one, adopted by DHL, is a multi-hub network configuration with a main hub and five regional hubs serving a particular geographic area. The difference between DHL network and its competitors is due to a combination of factors. First of all, DHL benefits a strong market position in Europe and absorb sufficient quantity of freight to justify such heavy structures. Secondly, DHL is likely to use more intensively air transport than TNT which found its strategy on ground network. Then thirdly, this network is more flexible to serve new destinations. The comparison of temporal organisation between FedEx and DHL revealed differences due to different focus in term of market served. FedEx uses the differing time zones to optimise transatlantic deliveries from Europe to the US in order to be more competitive on this market segment.

Moreover, the hub location switch to Leipzig will not at short and medium term perspective change this configuration as the sub hub will remains present in the network except for the case of Cologne that will become a gateway.

7 Conclusion & Recommendations

7.1 Chapter Background

This paper provides an analysis of the main integrators' networks on the European network as well as a comparison of the four integrators' strategies. The analysis was structured in three points, defined as the objectives. This chapter will, first, draw conclusions in accordance with the three objectives, and then will present the recommendations for further studies.

Prior the analysis, several possible factors have been revealed. The main one is the relation between market size and strategy with network configurations in Europe. Indeed, it has been recognised that on one side DHL, in situation of market leader, and UPS which has invested heavily in Europe in the past and should operate a more developed air network than TNT, relying heavily in road transportation and FedEx did not focus until recently to the intra-european market.

7.1.1 Determine the key factors influencing Integrators in European Hub selection

The methodology used to find key drivers for central hub selection was based on comparison between the different integrators hub location supported by the case study of DHL move to Leipzig. The case study used weighted average distance calculation, between the central hub and core markets. The first finding of this analysis is the presence of a strategic geographical area in Europe. Indeed, Doganis and Del Marmol's states that the best place to locate a central hub in Europe was within an area between Cologne-Paris-Amsterdam. The position of both Cologne and Liege hub operated respectively by UPS and TNT has revealed their proximity to the current core markets. Moreover, Leipzig is revealed more distant to DHL markets than Brussels. However, this analysis needs to be balanced by the future opportunities given Eastern European countries and the sensitive issue of night operation curfew. The second finding is the presence of common drivers in the integrators hub location. Indeed, the

first and main factor found is the role of market proximity while selecting a hub. Moreover interviews of professionals revealed others significant factors in the process as follow. Airport capacity¹⁴⁰, environmental restrictions¹⁴¹, operational cost and capacity of driving traffic are also key factors influencing airport selection for central hub.

7.1.2 Identify hub and spoke network configurations selected by integrators

Two trends emerged out from the route map analysis in the European market. First of all, the hub and spoke model is still the reference for integrator network designs. Secondly, two hub and spoke configurations are used by integrators, the single hub and spoke network with pickup stopovers and feeders is applied by FedEx, TNT and UPS. The three integrators founded their networks on a single hub, Paris for FedEx, Liege for TNT and Cologne for UPS. The second configuration is the multi-hub and spoke model with a central and several regional hubs serving a specific geographic area. DHL central hub is based at Brussels but will be switch to Leipzig. The DHL regional hubs are Bergamo, East Midland, Copenhagen, Vitoria and Cologne.

7.1.3 Identify strategies behind such configurations

Network configuration relies on the integrators' strategies. Several factors influence networks designs, specifically two of them: the size of the business and the transportation strategy. Several cases analysed in the paper support this conclusion, especially DHL's network in Europe. DHL is the market leader in both intra-European and Europe-international markets. Consequently this company carries a significant amount of traffic. This situation coupled with a long air transportation tradition explains partially the reason for a multi-hub

¹⁴⁰ This term includes slots restrictions, runway capacity, and possibility of building logistics facilities.

¹⁴¹ Includes night curfew and environmental concerns of the local community

network configuration in Europe. Indeed, when looking at DHL's network in the US, where the company has only the third position, the reader can observe a single hub and spoke network. The case of FedEx's network is similar, except the opposite market situation.

The second factor that was found is proven by the TNT situation. The company's activities in the European market are relatively large with a second position in the intra-European market. However, the company's air network is applying a single hub and spoke configuration due to a limited use of air transport for more intensive road transportation.

“FedEx is a network of networks ...”¹⁴²

7.2 Recommendations

This paper provides a specific approach to analyse integrators' network performances through a central hub location. Two directions can be investigated in further research.

First of all, due to a lack of route data, the measure of concentration planned to be used in order to assess the degree of dependency on the central hub was not carried out. A model could be developed in order to determine the factors influencing route selection in the framework of the integrators' business.

Secondly, looking at John Gardiner's paper on airport choice for non-integrated carriers and the latter research, further research could be carried out on integrators hub selection using survey and data modelling.

¹⁴² (FedEx Annual, 2006)

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